BHP Mitsubishi Alliance

Appendix I

Aquatic Ecology Impact Assessment

Blackwater Mine – North Extension Project

Aquatic Ecology Impact Assessment

Prepared for: SLR Consulting Australia Pty Ltd on behalf of BM Alliance Coal Operations Pty Ltd

Prepared by Ecological Service Professionals Pty Ltd

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Executive Summary

This aquatic ecology impact assessment report has been prepared by Ecological Service Professionals (ESP) for SLR Consulting Australia (SLR) on behalf of BM Alliance Coal Operations Pty Ltd (BMA) and describes the existing aquatic environment for the Blackwater Mine (BWM) – North Extension Project (the Project). It also assesses the potential impacts associated with the Project on aquatic ecological values and stygofauna communities, and outlines the proposed measures to minimise, manage or prevent potential adverse impacts. The BWM is located approximately 20 kilometres (km) south of Blackwater in central Queensland and has been in operation since 1967. BMA is proposing to extend mining operations at BWM into Surface Area (SA)10 on Mining Lease (ML) 1759 and SA7 on ML1762, located adjacent (to the east) of the existing BWM.

The purpose of this aquatic ecology impact assessment is to summarise aquatic habitats, flora and fauna as well as stygofauna communities known or likely to occur within and in the vicinity of the Project area based on the results of baseline seasonal surveys completed by EMM (2023a), a stygofauna pilot study completed by Freshwater Ecology (2021), and available desktop information. In addition, potential impacts and measures to minimise, manage and / or prevent potential adverse impacts on the aquatic ecological values of the waterways, wetlands and stygofauna communities are assessed.

Aquatic habitat in waterways and wetlands within the Project area was typical of ephemeral systems in the broader region, with seasonal patterns in habitat availability and quality. Waterways (i.e., creeks and tributaries) were generally dry during the baseline surveys, with isolated dry season refuges recorded at farm dams (lacustrine wetlands) and a flood channel wetland. There are no mapped palustrine wetlands within the Project area or downstream to the Mackenzie River, but there are several small palustrine wetlands on upstream and adjacent waterways. Water quality in waterways and wetlands in the vicinity of the Project was highly variable, which is typical of ephemeral systems in the region. Sediment was typically dominated by fine particles, including silt, clay and sand, and sediment quality is generally good, with a low concentration of most metals and metalloids.

Biological communities (including aquatic plants, macroinvertebrates, macrocrustaceans, fish and turtles) recorded at sites in the Project area were typical of ephemeral systems in central Queensland. All taxa recorded were common in the broader region, and no listed threatened species known from the catchment (or potential habitat for these species) were identified.

Emergent growth forms dominated aquatic plant communities, with few submerged and floating species, indicating that water was not likely to persist for the majority of the year (except at farm dams). Three species listed as priority flora have been recorded within the Project area. Two introduced aquatic plants, none of which are Weeds of National Significance, have been recorded within the Project area.

Macroinvertebrate communities sampled in the baseline surveys were in poor to moderate condition relative to those expected in the broader region, with few sensitive taxa. Results indicated unfavourable physical conditions and / or reduced habitat quality, likely reflecting seasonality and the ephemeral nature of waterways in the region, rather than catchment impacts. Long-term monitoring conducted by BWM as part of the Receiving Environment Monitoring Program (REMP) indicated communities are typically dominated by common taxa

that are tolerant of harsh physical conditions. REMP results indicate that mining has had no negative influence on the health of macroinvertebrate communities. Macroinvertebrate communities at sites downstream of BWM on higher stream orders were often in better condition than those upstream.

During the baseline surveys, nine species of common native fish were recorded, with communities dominated by small bodied species. Two restricted noxious fish have been recorded in waterways within the vicinity of the Project, one of which has been recorded within the Project area. Waterways within the Project area and downstream are mapped as waterways providing for fish passage in the *Waterway Barrier Works* spatial layer, a Matter of State Environmental Significance, with a low, moderate, high or major risk of adverse impacts to fish passage as a result of waterway barrier works. Turtles were not particularly abundant or widespread within the Project area. There are no records of platypus in the vicinity of the Project and given the ephemeral nature of waterways, the baseline assessment determined that no suitable habitat for platypus is present in the Project area.

Overall, aquatic ecosystem values of waterways and wetlands within the Project area were low to moderate, and were considered to be similar to and representative of ephemeral systems in the broader region. Waterways with higher stream orders (i.e. stream order 3 and above) typically had higher ecological value than waterways with low stream orders (i.e. stream order 1 and 2). Wetlands were assessed as having moderate aquatic ecological value (particularly due to their provision of dry season refuge for aquatic flora and fauna).

Direct impacts to waterways and wetlands (water resources) from the Project are restricted to the Project footprint, which includes low stream order and low value waterways and wetlands (farm dams). This is not expected to impact aquatic ecology on a regional scale, but rather on a localised scale within the Project footprint. The character, resilience and values of waterways and wetlands will be managed and monitored to protect EVs of the receiving environment. Releases of Mine Affected Water will occur in compliance with the existing Environmental Authority (EA) conditions, and existing BWM management plans (including the BWM Water Management Plan, Erosion and Sediment Control Plan, Waste Management Plan, Air Emissions Management Plan and Progressive Rehabilitation Closure Plan [to be developed]), which will be reviewed and updated, if required, to incorporate the Project. The Project is expected to have a minor impact on streamflow or flood flows, and therefore potential impacts on aquatic ecology are expected to be of low risk.

The majority of waterways within the Project footprint are mapped as having low and moderate risk of impact to fish passage in the *Waterway Barrier Works* mapping layer. While the Project would remove these ephemeral low value waterways and moderate value wetlands providing fish habitat within the Project footprint, it would not fragment fish habitat as they do not connect to fish habitat further upstream. A proposed dragline crossing over Deep Creek (waterway mapped as high risk of impact to fish passage) will be constructed at bed level to allow fish passage, and crossings will only occur in the dry. An infrastructure corridor crosses Taurus Creek, where it is mapped as a major risk of impact to fish passage. The waterway at this crossing is ephemeral, moderate ecological value (with fauna common in the region) and there are existing limitations to fish passage further upstream (onstream dams). Fish passage at this crossing will be maintained by designing culverts in general accordance with the Accepted Development Requirements for high risk waterway barrier works and the Department of Transport and Main Roads Drainage Manual.

Pest species in the region include two restricted fish and introduced weeds. Weed management (prevention, monitoring and control) will be undertaken to minimise the potential for an increase in abundance and/or species of weeds. Standard weed hygiene protocols will be implemented (in accordance with the existing BWM Land and Biodiversity Management Plan), and as such risks are expected to be minor.

There are no known surface expression Groundwater Dependent Ecosystems (GDEs) mapped within the Project area. The baseline survey results indicated there was no obvious groundwater influence within the Project area, including no flows, salt seeps, hydrophytes, or other aquatic GDE indicators following prolonged dry conditions, and no obvious groundwater influence on the concentrations of major anions and cations in surface water. One aquatic system, Blackwater Creek, (located outside of the Project area to the north-east and downstream) is mapped as having moderate potential for groundwater interaction. While surveys have not been completed in this watercourse, which occurs to the east of the Project area, desktop assessments indicate a moderate aquatic ecological value. This is similar to other waterways in the region that are not mapped as GDEs. Changes to the net groundwater flow to Blackwater Creek due to the Project are expected to be minor.

There are no potential subterranean GDEs mapped within the Project area and no true stygofauna have been found in the vicinity of the Project (with only stygoxenes recorded). Alluvium (where stygofauna are most common) is limited and generally dry in the vicinity of the Project, and water quality (particularly electrical conductivity) is generally outside the range known to support stygofauna communities. As such, aquifers in the Project area have a low likelihood of supporting stygofauna communities, and potential impacts to stygofauna are unlikely.

Overall, where mitigation and management measures are effectively implemented, potential impacts from the Project are of low risk to aquatic ecosystem values.

1 Introduction

This aquatic ecology impact assessment report has been prepared by Ecological Service Professionals (ESP) for SLR Consulting Australia (SLR) on behalf of BM Alliance Coal Operations Pty Ltd (BMA) for the Blackwater Mine (BWM) – North Extension Project (the Project).

An aquatic ecology baseline assessment was completed for the Project by EMM (EMM 2023a and provided in **Attachment A**). The aim of the baseline assessment was to describe the aquatic values of the BWM North Extension Project Area as relevant to Commonwealth and State legislation, based on desktop review of available information, and seasonal field surveys completed in December 2019 and May 2020. A stygofauna pilot survey was also completed for the Project by Freshwater Ecology over two sampling events in November 2020 and May 2021 (Freshwater Ecology 2021 and provided in **Attachment B**).

This aquatic ecology impact assessment report summarises the results of the baseline aquatic ecology assessment (EMM 2023a), the stygofauna pilot study (Freshwater Ecology 2021), along with other available desktop information, to evaluate the existing aquatic ecological values and stygofauna communities relevant to the Project. It also assesses the potential impacts associated with the Project on aquatic ecological values and stygofauna communities, and outlines proposed measures to minimise, manage or prevent potential adverse impacts.

1.1 Project Background

The BWM is located approximately 20 kilometres (km) south-west of Blackwater within the Mackenzie River sub basin, Queensland (**Figure 1.1**). BWM's Mining Leases (MLs) include ML1759, ML1760, ML1761, ML1762, ML1767, ML1771, ML1772, ML1773, ML1792, ML1800, ML1812, ML1829, ML1860, ML1862, ML1907, ML70091, ML70103, ML70104, ML70139, ML70167 and ML70329.

The BWM has been in operation since 1967 and operates in accordance with, amongst other authorisations, Environmental Authority (EA) EPML00717813, granted under the Queensland *Environmental Protection Act 1994* (EP Act). The BWM produces up to 16 million tonnes per annum (Mtpa) of product coal.

BMA seek relevant State and Federal approvals to extend the current mining operation through the Project. The Project would extend the mining area of the existing BWM to within Surface Area (SA)10 on ML1759 and SA7 on ML1762 and increase BWM production to up to 17.6 Mtpa (product coal). Importantly, the Project should be viewed in the context that it is an extension and continuation of ongoing mining operations on a portion of the significantly larger BWM mining operation.

The key elements of the Project include, but are not limited to, the following:

- vegetation clearing, the removal and stockpiling of topsoil material, drilling and blasting of overburden and interburden material;

- removal of overburden and interburden material (dragline and truck and shovel/excavator methods) to uncover coal, which is placed as back fill in the mined-out pit voids (in-pit spoil dumps) as mining advances;
- open cut mining (truck and shovel/excavator methods) of ROM coal from the coal measures in SA10 on ML1759 and SA7 on ML1762;
- continued use of BWM infrastructure (e.g. Coal Handling and Preparation Plant [CHPP], Thermal Coal Plant [TCP], RoM and product stockpiles, train load-out, water management system and other supporting infrastructure);
- continued disposal of rejects and tailings in accordance with the EA;
- construction and operation of new or relocated infrastructure within SA10 on ML1759 and SA7 on ML1762 to facilitate and/or support the open cut mining extension such as back access roads, access tracks, water management infrastructure and powerlines, laydown areas and build pads;
- a new dragline crossing across Deep Creek;
- ongoing exploration activities within ML1759 and ML1762; and
- progressive rehabilitation of the mine site.

SA7 on ML1762 and SA10 on ML1759 cover a total area of approximately 9,010 hectares (ha). The extent of the proposed Project open cut mining area and out of pit disturbance areas is approximately 3,761 ha. If approved, and subject to customer demand, the extension is projected to extend mining at the BWM to within SA7 on ML1762 and SA10 on ML1759 from 2025 to 2085.

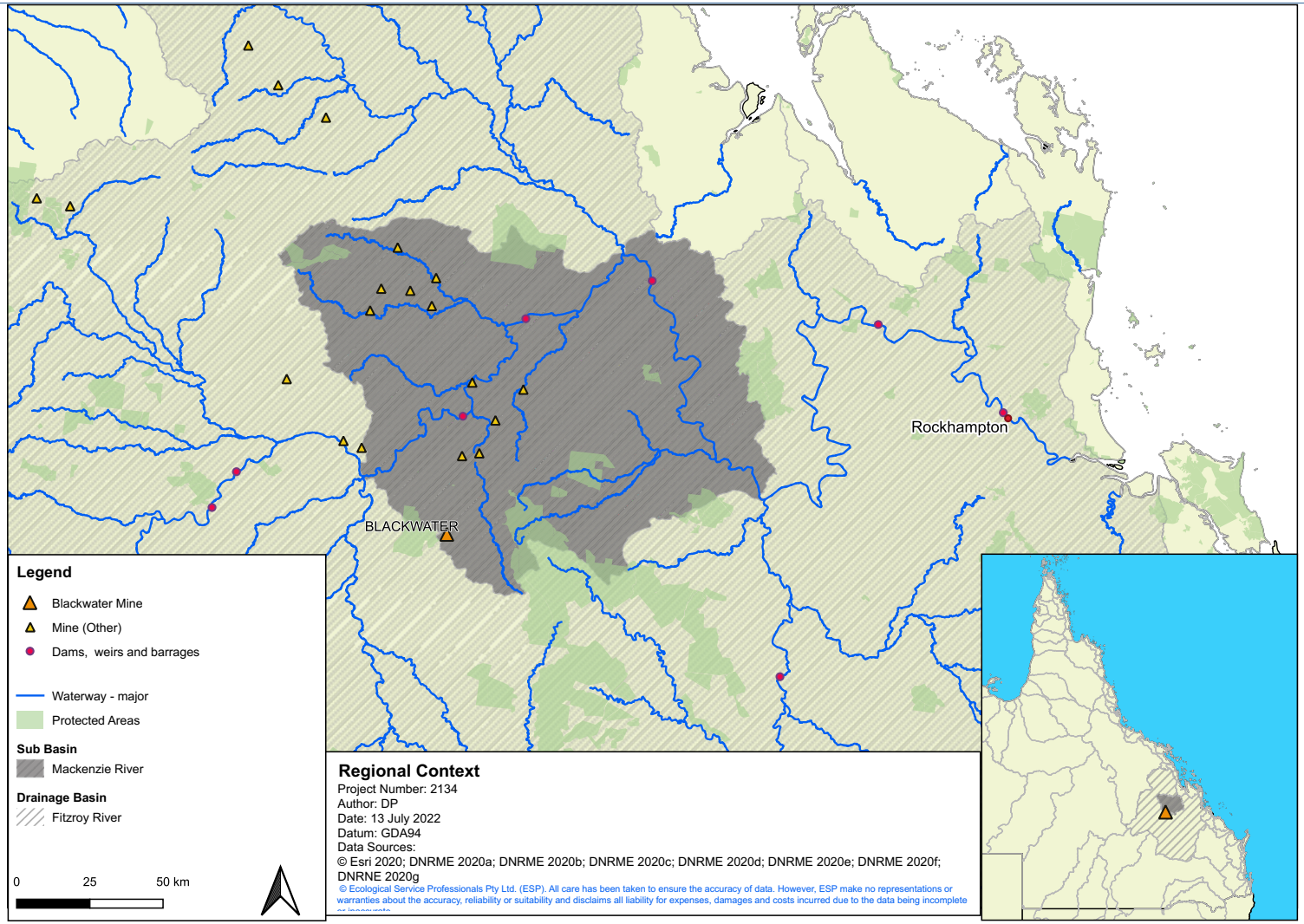

Figure 1.1 Regional Context

1.2 Scope of the Assessment

The purpose of this aquatic ecology assessment report is to:

- summarise the baseline aquatic ecological values of waterways within, upstream and downstream of the proposed Project area based on a desktop review of available databases and literature review, as well as the aquatic ecology field surveys undertaken by EMM (2023a) (**Attachment A**);
- assess the potential likelihood of occurrence of any aquatic Matters of National Environmental Significance (MNES) and Matters of State Environmental Significance (MSES) within and in the vicinity of the BWM North Extension Project area;
- summarise stygofauna communities known from or likely to occur in the groundwater aquifers of the region, as informed by the desktop review and stygofauna surveys completed by Freshwater Ecology (2021) (**Attachment B**);
- assess the risk and magnitude of potential impacts of the Project on the aquatic ecological values and stygofauna; and
- describe the measures that will be implemented to minimise, manage and / or prevent potential adverse impacts.

1.3 Description of the Study Area

The Project area comprises SA7 on ML1762 and SA10 on ML1759 (i.e. the BWM North Extension Project area; the baseline aquatic ecology study area in EMM 2023a). The study area for this aquatic ecology impact assessment comprises aquatic habitats within the Project area, upstream of the Project area and downstream of the Project area in the receiving environment of Blackwater Creek. Waterways, wetlands and watercourses within the Project study area are described below.

1.3.1 Waterways in the Vicinity of the Project

A waterway is defined under the *Fisheries Act 1994* (Fisheries Act) as freshwater and tidal waters, both permanent and ephemeral, including a drainage feature, river, creek, stream, watercourse, or inlet of the sea. There are several waterways within the Project area and downstream, as shown on **Figure 1.2**. These include (SLR 2023a):

- Two Mile Gully and its associated tributaries, the headwaters of which are located to the south east and within the southern part of the Project area. These waterways flow in a north easterly direction, joining Taurus Creek approximately 6 km downstream of the Project footprint. Two Mile Gully has a total catchment area of approximately 160 square kilometres (km^2). The Two Mile Gully catchment contains two major tributaries of the primary watercourse, located to the east and west respectively. Approximately 16 km^2 of the natural catchment of the western tributary is diverted to Taurus Creek via the existing diversion channel.
- Deep Creek, the tributaries of which originate to the west of BWM and flow in a north easterly direction between active mining areas of BWM (parallel with Taurus Creek) and joins Taurus Creek immediately downstream of Taurus Road. Deep Creek has a

catchment area of approximately 35 km^2. The Deep Creek watercourse traverses between active mining areas via the Deep Creek Diversion, which conveys flows to the New Deep Creek Dam. The New Deep Creek Dam is an on-line structure and flows discharging from the Dam continue in an easterly direction for approximately 3.5 km before joining at the confluence with Taurus Creek.

- Taurus Creek, the tributaries of which originate to the west of BWM and flow in a north easterly direction between active mining areas of BWM as well as immediately west of the Project footprint in a north easterly direction, where it joins with Blackwater Creek. Taurus Creek has a catchment area of approximately 300 km^2, encompassing Deep Creek and Two Mile Gully. There are two Mine Affected Water (MAW) dams (Ramp 42 Fill Point Dam and New Taurus Creek Dam) located on Taurus Creek that release MAW in accordance with the conditions in the existing EA. Taurus Creek discharges into Blackwater Creek approximately 15 km downstream of the New Taurus Creek Dam and approximately 4 km downstream of the Project footprint.
- Sagittarius Creek, the upstream tributaries of which originate in the Project area and flows off-site passing to the west of Blackwater, then joining Blackwater Creek, approximately 12 km downstream of the Project. The total catchment area of Sagittarius Creek is approximately 70 km^2. It discharges the Project area via existing culverts under the Blackwater Siding Railway and then continues for a further 7.5 km, running along the western extent of the town of Blackwater before discharging into Blackwater Creek 2 km upstream of Curragh East mine.
- Blackwater Creek, which is located to the east of the Project area and flows in a northerly direction to the east of Blackwater, joining the Mackenzie River approximately 40 km downstream of the Project, and ultimately joining the Fitzroy River and flowing to the Coral Sea at Rockhampton. Blackwater Creek encompassing a catchment area of 280 km^2 draining to the confluence with Taurus Creek. Neither Blackwater Creek nor the Mackenzie River are within the Project area but are located downstream.

1.3.2 Wetlands in the Vicinity of the Project

There are a number of definitions for wetlands, of which the *Queensland Wetlands Program* (DES 2015), consistent with the *Strategy for the conservation and management of Queensland's wetlands* (EPA 2005), defines a wetland as areas of permanent or periodic / intermittent inundation, with water that is static or flowing fresh, brackish or salt, with one or more of the following attributes:

- at least periodically the land supports plants or animals that are adapted to and dependent on living in wet conditions for at least part of their life cycle; or
- the substratum is predominantly undrained soils that are saturated, flooded or ponded long enough to develop anaerobic conditions in the upper layers; or
- the substratum is not soil and is saturated with water, or covered by water at some time.

There are three main types of wetland systems for surface freshwater environments (DES 2015; EPA 2005):

- Palustrine wetlands (e.g. billabongs, swamps, bogs, springs, soaks) are primarily vegetated non-channel environments of less than 8 ha and have more than 30% emergent perennial vegetation (e.g. trees, shrubs and emergent macrophytes, mosses or lichens).
- Lacustrine wetlands (e.g. lakes and dams) are open water-dominated systems that are larger than 8 ha, have less than 30% coverage of emergent perennial vegetation and include wetlands and deep water habitats in topographic depressions, dammed river channels or artificial waterbodies.
- Riverine wetlands are all wetlands and deep-water habitats within a channel, which are naturally or artificially created, periodically or continuously contain moving water, or connecting two bodies of standing water.

The *Queensland Wetlands Program* (DES 2015) delineates wetlands throughout Queensland. There are several mapped lacustrine wetlands within the Project area and in the vicinity of the Project, with most of these lacustrine wetlands associated with farm dams and BWM water storages upstream of the Project area (**Figure 1.2**). Several farm dams that are unmapped but may provide aquatic habitat are also located upstream, within and downstream of the Project area. Palustrine wetlands are also mapped in the region, none of which are within the Project area or downstream to the Mackenzie River. However, there are several small palustrine wetlands on upstream and adjacent waterways, including on Two Mile Gully, approximately 1.5 km east of the Project and on Deep Creek, approximately 6 km west of the Project (**Figure 1.2**).

There are no High Ecological Significance (HES) wetlands regulated under the *Environmental Protection Act 1994* (EP Act) within the Project area and the closest downstream HES wetland is more than 75 km away on the Mackenzie River. The closest HES wetland that is not downstream is located >20 km to the south-east. No wetlands of International or National importance occur in the Mackenzie River sub-basin (DES 2013b).

1.3.3 Watercourses in the Vicinity of the Project

A watercourse is defined under the *Water Act 2000* (Water Act) as a river, creek or other stream, including a stream in the form of an anabranch or a tributary, in which water flows permanently or intermittently, regardless of the frequency of flow events, and does not include drainage features (that lack a natural or artificial channel). Within the Project area, Taurus Creek downstream of its confluence with Two Mile Gully (within SA7 of ML1762) is a 'watercourse' as defined by the Water Act (**Figure 1.3**). In addition, Two Mile Gully within and upstream of the Project area (in the southern section of SA7 of ML1762) is defined as a 'drainage feature'. Blackwater Creek downstream of its confluence with Taurus Creek, is also defined as a 'watercourse' under the Water Act. There are also mapped 'drainage features' upstream of the Project area that drain in a northerly direction adjacent to BWM. All other waterways upstream of and within the Project footprint are 'unmapped' (i.e. yet to be defined) under the Water Act. These unmapped waterways within the Project area would be classified as drainage features (SLR 2023a).

1.3.4 Mackenzie River Sub-Basin

Waterways and wetlands within the Project area are all within the Mackenzie River sub-basin, which is part of the wider Fitzroy River basin (refer to **Figure 1.1**). The Mackenzie River sub-basin covers an area of approximately 13,000 km^2 and the wider Fitzroy River basin covers an area of approximately 140,000 km^2 (DES 2013a). The Mackenzie River originates near Comet at the confluence of the Comet and Nogoa rivers, and flows northeast, north of the settlement of Royles (where it is joined by the Isaac River to the north), before flowing southeast. At its confluence with the Dawson River northeast of Duaringa, more than 90 km east of the Project area, it forms the Fitzroy River, which flows initially north and then east towards the east coast of Queensland and discharges into the Coral Sea southeast of Rockhampton, over 200 km east (straight line) of the Project (refer to **Figure 1.1**).

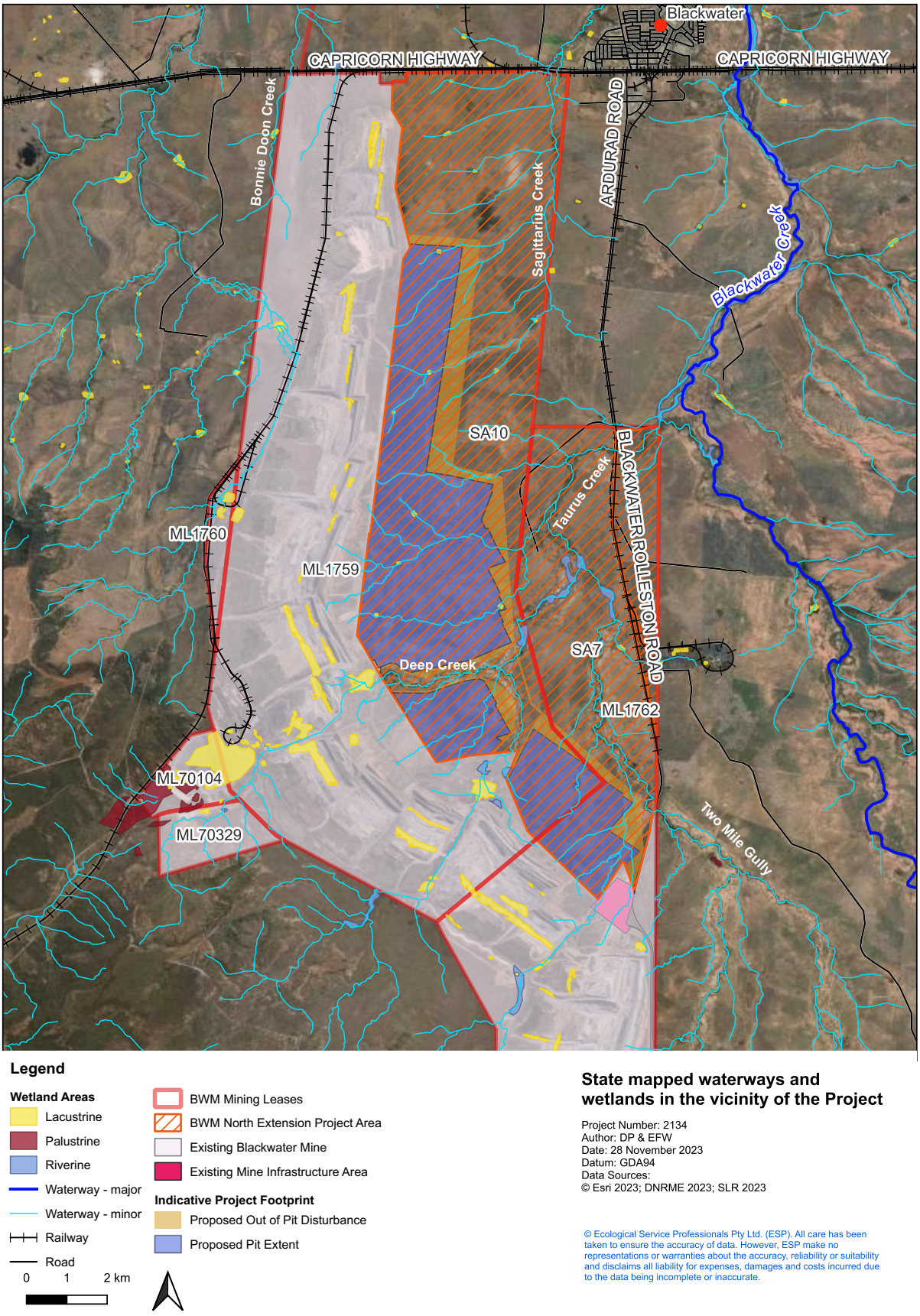

Figure 1.2 State mapped waterways and wetlands areas in the vicinity of the Project

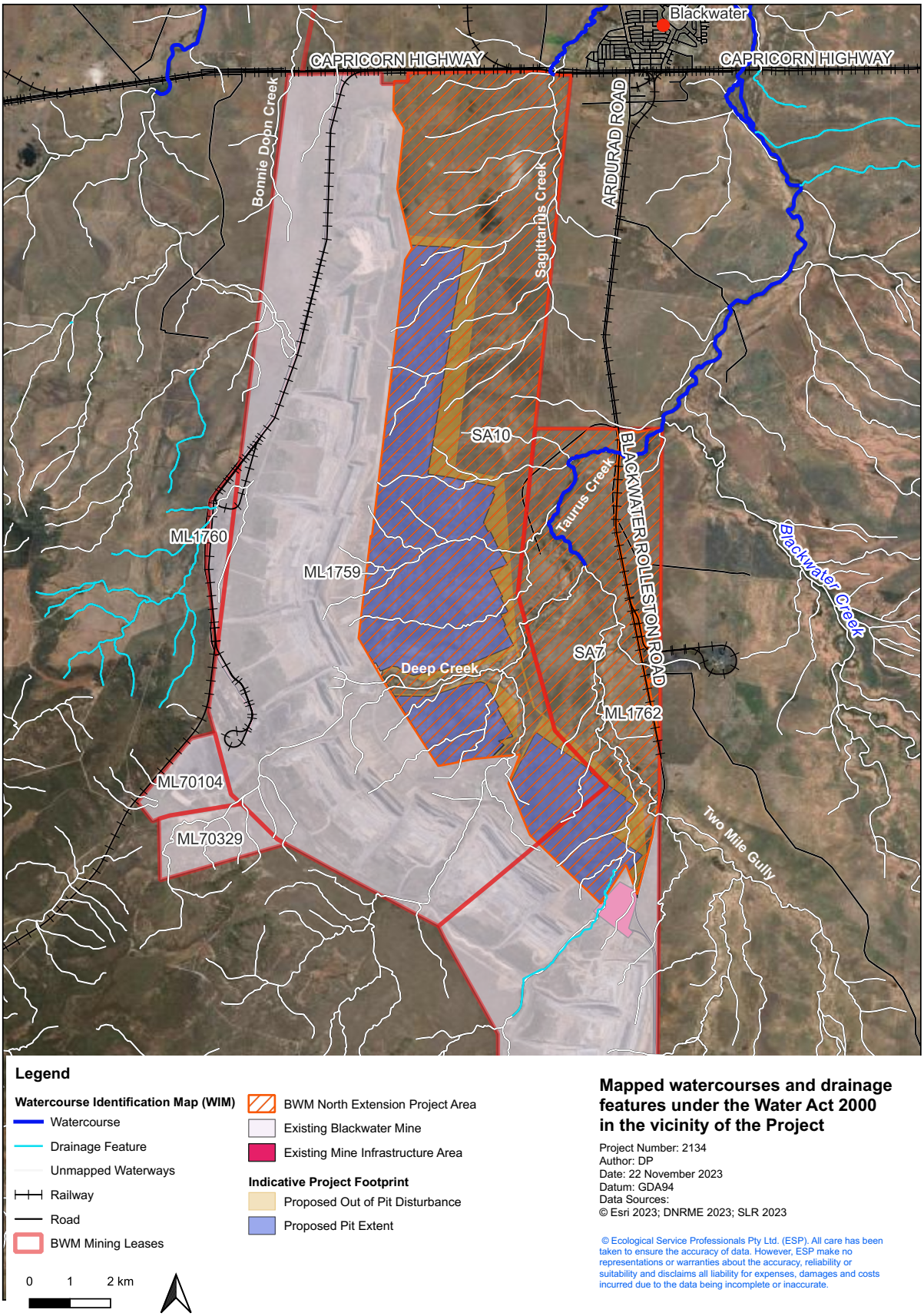

Figure 1.3 Mapped watercourses and drainage features under the Water Act 2000 in the vicinity of the Project

1.4 Relevant Legislation, Policies and Guidelines

The relevant legislation, policies and guidelines relating to aquatic ecology and stygofauna communities within and in the vicinity of the Project area are summarised in **Table 1.1**. Key items relating to aquatic ecology and stygofauna are:

- the potential presence of aquatic species listed under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and / or *Nature Conservation Act 1992* (NC Act), specifically:
    - silver perch (*Bidyanus bidyanus*)
    - Murray cod (*Maccullochella peelii*)
    - Fitzroy River turtle (*Rheodytes leukops*)
    - white-throated snapping turtle (*Elseya albagula*), and
    - platypus (*Ornithorhynchus anatinus*);
- the presence of water resources (waterways, wetlands and potential surface expression Groundwater Dependent Ecosystems [GDEs]);
- mapped waterways under the Queensland *Waterways for Waterway Barrier Works* spatial layer within and adjacent to the Project area;
- the presence of pest species of aquatic plants and animals;
- environmental values (EVs) of waterways and Water Quality Objectives (WQOs) for the protection of the relevant EVs; and
- the presence of mapped watercourses and drainage features under the Water Act on the *Watercourse Identification Map* (WIM).

Regional ecosystems, an MSES protected under the Queensland *Vegetation Management Act 1999* (VM Act), including those associated with waterways and wetlands, are assessed in the *Blackwater Mine - North Extension Project Matters of State Environmental Significance Report* (EMM, 2023b) and not considered in this report.

Table 1.1 Summary of relevant legislation, policies and guidelines relating to aquatic ecology that are relevant to the Project

Legislation / Policy / Guideline	Synopsis	Relevance	Relevant Report Section
Commonwealth			
EPBC Act and the EPBC Act *Environmental Offsets Policy* (EPBC Act EO Policy)	Provides for the protection and management of nine MNES.	Relevant MNES include: • the potential for listed threatened aquatic species to occur; and • water resources (including GDEs) in relation to coal seam gas development and large coal mining development.	The potential for aquatic MNES to occur within the Project area and in the vicinity of the Project is discussed in **Section 3.9**, with GDEs assessed in **Section 3.7.** Significant residual impacts on MNES are assessed in **Section 5.13**.
Queensland			
EP Act and the subordinate *Environmental Protection Regulation 2019* (EP Regulation)	Provides the basis for effective and efficient management of the natural environment within the context of ecologically sustainable development.	Regulates resource activities, including mining, and provides an approval system (EAs) for environmentally relevant activities (ERAs). There are no aquatic Environmentally Sensitive Areas (ESAs) in the vicinity of the Project.	The character, resilience and values of waterways and wetlands, including MSES, fish passage and HES wetlands, are described in **Sections 3** and **4.**

Legislation / Policy / Guideline	Synopsis	Relevance	Relevant Report Section
EP Act and the subordinate *Environmental Protection (Water and Wetland Biodiversity) Policy 2019* (EPP (Water and Wetland Biodiversity))	Seeks to protect the quality of natural waters in Queensland while supporting ecologically sustainable development.	EVs and WQOs have been defined for the Mackenzie River sub-basin under Schedule 1 of the EPP (Water and Wetland Biodiversity). There are no high ecological value (HEV) waterways or wetlands within the Project area or downstream waterways in the Mackenzie River sub-basin. There are no HES wetlands (designated as a wetland protection area (WPA) in Great Barrier Reef catchments) within the Project area or in the vicinity of the Project, with the closest downstream HES wetland more than 75 km away on the Mackenzie River.	The aquatic ecological values of wetlands and waterways protected under the EPP (Water and Wetland Biodiversity) are described in **Sections 3.2, 3.7** and **3.10.** Water and sediment quality of waterways in the region is discussed in **Sections 3.2.2** and **3.3**.
Environmental Offsets Act 2014 (Offsets Act) and the subordinate *Environmental Offsets Regulation 2014* (Offsets Regulation)	Seeks to counterbalance the significant residual impacts of particular activities on prescribed environmental matters through the use of environmental offsets.	An environmental offset may be required as a condition of approval where, following consideration of avoidance and mitigation measures, a prescribed activity is likely to result in a significant residual impact on a prescribed environmental matter(s).	Significant residual impacts on MSES are assessed in **Section 5.14**.
Fisheries Act and the subordinate	Seeks to achieve economically viable, socially acceptable and ecologically sustainable development of Queensland's	Waterway barrier works approval may be required if new waterway crossings are constructed or existing crossings are modified outside of the Mining Lease	The fish habitat value of the waterways in the vicinity of the Project are summarised in **Sections 3.6.1, 3.8.1** and **3.10**.

Legislation / Policy / Guideline	Synopsis	Relevance	Relevant Report Section
Fisheries Regulation 2008	fisheries resources. Measures are designed to protect fisheries resources, include regulation of waterway barrier works, declaration of fish habitat areas and protection of marine plants.	but as part of the Project where accepted development requirements cannot be met. Waterway barrier works approval under the Fisheries Act is not required within the Mining Lease. However, waterways within and adjacent to the Project footprint are mapped on the *Queensland Waterways for Waterway Barrier Works* spatial layer and as such impacts to fish passage will be considered under the EP Act and / or Offsets Act.	
NC Act and subordinate Nature Conservation (Animals) Regulation 2020 and Nature Conservation (Plants) Regulation 2020	Provides for the protection of critically endangered, endangered, vulnerable and near threatened species of flora and fauna as listed under the Nature Conservation Regulations.	Listed threatened aquatic species are present in the Mackenzie River sub-basin.	The potential for listed threatened aquatic species to be present within the Project study area is discussed in **Sections 3.8.2** and **3.9.1**.

Legislation / Policy / Guideline	Synopsis	Relevance	Relevant Report Section
Biosecurity Act 2014	Provides a framework for the improved management of weeds and pest animals.	Potential aquatic pest plants (also recognised nationally as Weeds of National Significance (WoNS)) and pest animals that could have an adverse economic, environmental or social impact are present in the Mackenzie River sub-basin. Restricted aquatic matters recorded in the Project area include the mosquitofish (*Gambusia holbrooki*). Tilapia (*Oreochromis mossambicus*) have also been recorded in the region. Four introduced weeds have been recorded in the region, two of which have been recorded in the Project area. These were not WoNS or listed as a prohibited or restricted matter.	The potential for aquatic pest species in the vicinity of the Project is discussed in **Sections 3.4** and **3.6**.
Planning Act 2016 (Planning Act)	Establishes a system for land use planning, development assessment and related matters that facilitates the achievement of ecological sustainability.	The Planning Act does not apply to development authorised under the *Mineral Resources Act 1989*, unless the development is on a Queensland heritage place or involves work under the *Building Act 1975*.	Not relevant for the Project, as the Planning Act is only relevant where there are works outside of the mining lease.
Water Act	Provides for the sustainable management of water resources, including sustaining the health of ecosystems, water quality, water-dependent ecological processes and biological diversity associated with watercourses, lakes, springs, aquifers and other natural water systems	A riverine protection permit (RPP) is required to excavate, or place fill in a watercourse, lake or spring, where RPP exemption requirements cannot be complied with. A water licence may be required to interfere with watercourses. Diversion associated with an EA or resource activity are approved through the EA process.	The aquatic ecological values of mapped watercourses are described in **Section 3**, and specifically **Section 3.10**. The Project does not involve excavation or placing fill in a watercourse, lake or spring or interfering with watercourses outside of the mining lease. If activities proposed on-lease trigger an RPP and do not comply with the

Legislation / Policy / Guideline	Synopsis	Relevance	Relevant Report Section
	(including, where practicable, reversing degradation that has occurred). Empowers the State to plan for the sustainable management of water through water plans and water use plans (i.e. Water Plans (formerly Water Management Plans) and Water Management Protocols (formerly Resource Operations Plans)).	Watercourses are mapped on the WIM, including a section of Taurus Creek in the northern section of the Project area. There is also an unnamed tributary of Two Mile Gully in the southern section of Project area, which is mapped as a drainage feature.	RPP exemption requirements, then an RPP or water license will be required.

2 Methods

2.1 Aquatic Ecology

2.1.1 Baseline Surveys

An aquatic ecology baseline assessment was completed by EMM (EMM 2023a; **Attachment A**). The results of this aquatic ecology baseline assessment have been used to summarise the aquatic ecological values of the Project area and surrounds, along with an updated comprehensive desktop assessment (as outlined in **Section 2.1.2**).

Aquatic ecology surveys for the Project were completed by EMM in December 2019, aligning with the AUSRIVAS 'early wet' sampling season (October to December), and follow-up AUSRIVAS 'late wet' season surveys (May to July) were completed in May 2020. A total of ten sites were sampled within the Project area (**Figure 2.1**), including seven riverine, two lacustrine wetland and one riverine wetland sites (with the latter riverine wetland site only surveyed in May 2020). There was 15.4 mm of rain in the three months preceding the December 2019 survey (BOM 2023), representative of dry season/drought conditions. Combined rainfall of 270.2 mm was recorded in January and February 2020, with periods of intense rainfall resulting in flooding at each riverine site (EMM, 2023a). However, only 3.2 mm of rain was recorded in the three months preceding the May 2020 survey (BOM 2023), leading to dry conditions at most riverine sites. Given the dry conditions, comprehensive surveys (fish, turtles, macroinvertebrates, water quality, aquatic habitat and aquatic plants) were only completed at one riverine site (site R4) that contained isolated pools during both surveys. Aquatic habitat and plant surveys (only) were completed at the remaining riverine sites (sites R1, R2, R3, R5, R6 and R7) that were dry during both survey events. Comprehensive surveys were also completed at one lacustrine wetland (site L1) and the riverine wetland site (site RW1). Water quality, aquatic habitat and aquatic plant surveys (only) were completed at the other lacustrine wetland site (site L2). Detailed survey methods are in EMM (EMM 2023a; **Attachment A**).

2.1.2 Desktop Assessment

A comprehensive desktop assessment was completed to summarise the aquatic ecological values of the Project area and surrounds. The following sources were reviewed:

- receiving environment monitoring program (REMP) annual results reports for BWM from 2012 (Gauge Industrial & Environmental 2013), 2013 (Gauge Industrial & Environmental 2014), 2014 / 2015 (Hydrobiology 2016), 2015 / 2016 (Gauge Industrial & Environmental 2017), 2017 / 2018 (Hydrobiology 2019), 2019 / 2020 (Gauge Industrial & Environmental 2020), 2020 / 2021 (Gauge Industrial & Environmental 2021) and 2021 / 2022 (Gauge Industrial & Environmental 2023), sites surveyed are shown in **Figure 2.2** (i.e. REMP sites);
- Aquatic Conservation Assessment (ACA) for the riverine (Inglis and Howell 2009) and non-riverine (Rollason & Howell 2012) wetlands of the Great Barrier Reef catchment;
- Queensland Government surface *Water Monitoring Information Portal* (WMIP) (State of Queensland 2023);

- *EPBC Act Protected Matters Search Tool* for both 20 km and 50 km search radius around the Project area (DCCEEW 2023a; reports provided in **Attachment C**), and the Queensland *WildNet* database for both 20 km and 50 km search radius around the Project area (DES 2023a) to determine the aquatic species (including listed threatened species) that are known or are likely to occur in the vicinity of the Project;
- database searches of the species occurring in the area, including the *Atlas of Living Australia* (ALA 2023) and the Queensland Government *Wetland Info* species lists for the Mackenzie River sub-basin and Fitzroy River basin (DES 2013a: DES 2013b);
- existing mapping of the aquatic ecological values in the vicinity of the Project, including Queensland *Wetland Maps* (DES 2023b), *Waterways for Waterway Barrier Works* (DAF 2023) and *Queensland Globe*, including the WIM (Queensland Government 2023);
- publicly available reports from aquatic ecology assessments completed in the region; and
- other relevant published information from the region.

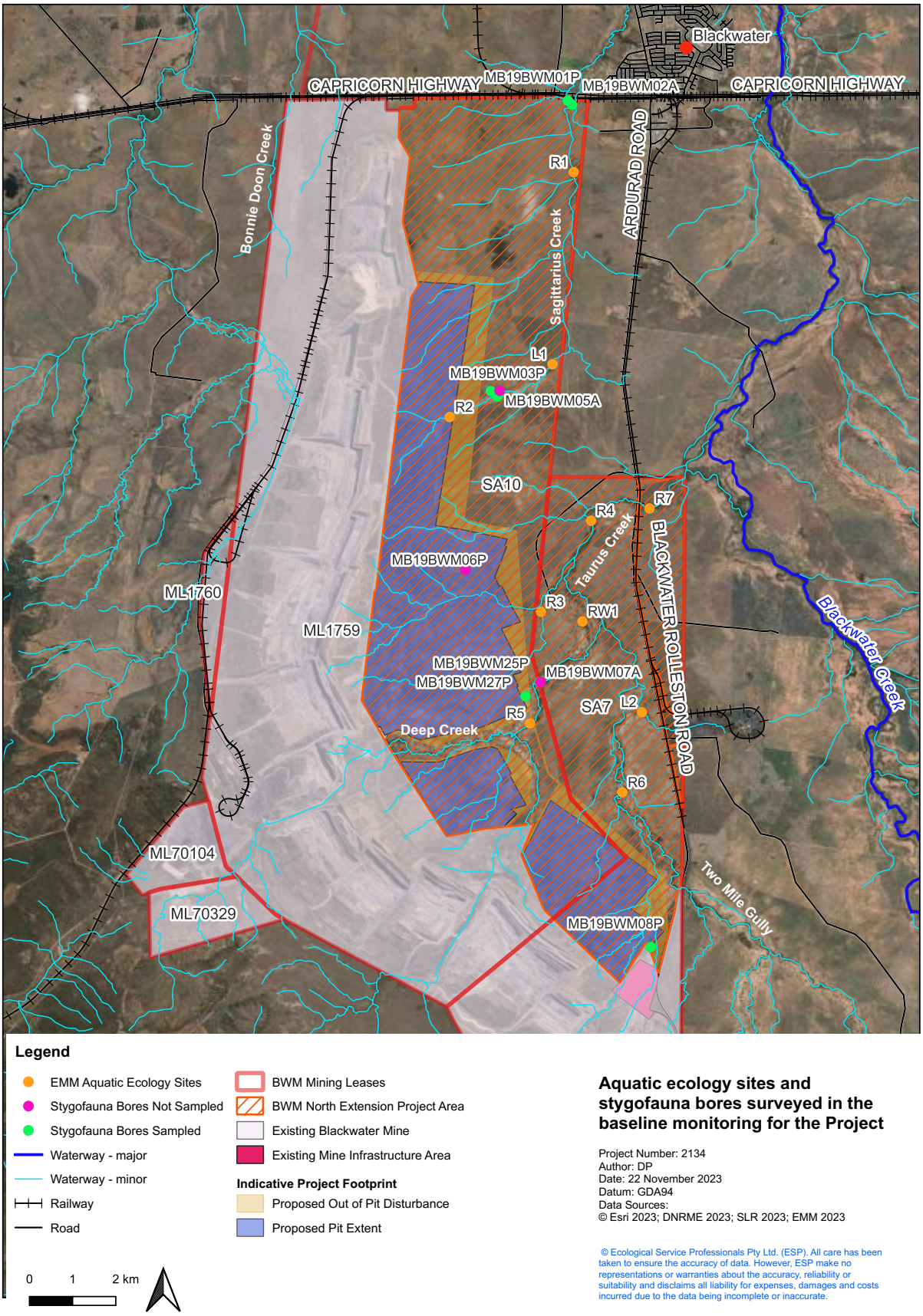

Figure 2.1 Aquatic ecology sites and stygofauna bores surveyed in the baseline monitoring for the Project

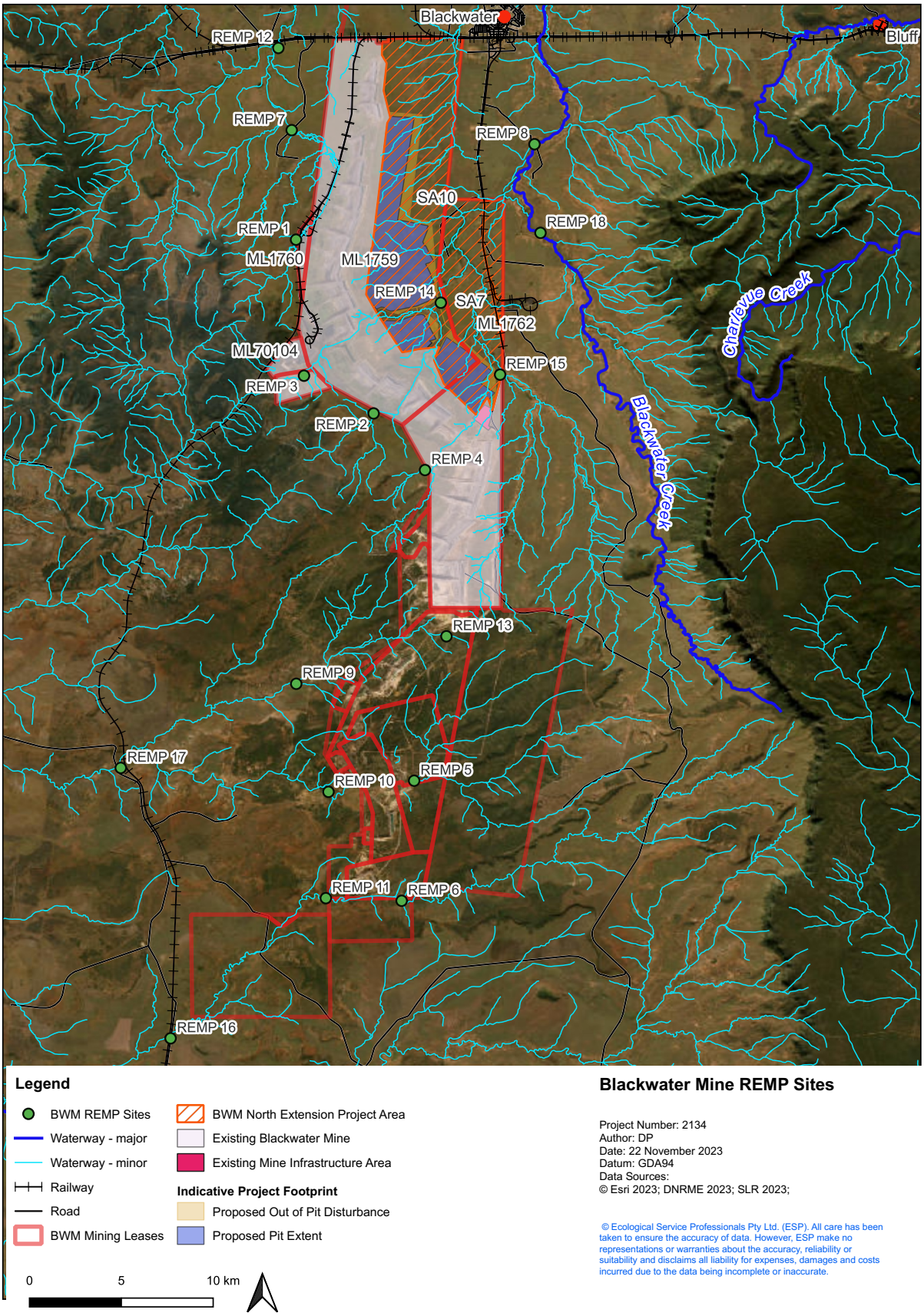

Figure 2.2 Blackwater Mine Receiving Environment Monitoring sites

2.1.3 Aquatic Ecosystem Values

The overall aquatic ecosystem values of the waterways and wetlands were identified based on the criteria outlined in **Table 2.1** developed in accordance with the *Guidelines for Identifying High Ecological Values Aquatic Ecosystems* (Aquatic Ecosystems Task Group 2012), which identifies five core criteria to determine aquatic ecosystem values:

- Diversity: The aquatic ecosystem exhibits exceptional diversity of species (native / migratory), habitats, and / or geomorphological features / processes. This includes diversity of ecosystem types (rivers, wetlands, subterranean systems, etc,), biotic diversity (within and between species) and / or abiotic (e.g. geomorphic) features and processes.
- Distinctiveness: The aquatic ecosystem is rare / threatened or unusual; and / or supports rare / threatened / endemic species / communities / genetically unique populations; and / or exhibits rare or unusual geomorphological features / processes and / or environmental conditions (and is likely to support unusual assemblages of species adapted to these conditions, and / or are important in demonstrating key features of the evolution of Australia's landscape, riverscape or biota).
- Vital Habitat: An aquatic ecosystem provides vital habitat for flora and fauna species if it supports unusually large numbers of a particular native or migratory species; and / or maintenance of populations of specific species at critical life cycle stages; and / or key significant refugia for aquatic species that are dependent on the habitat particularly at times of stress.
- Naturalness: The ecological character of the aquatic ecosystem is not adversely affected by modern human activity.
- Representativeness: The aquatic ecosystem is an outstanding example of an aquatic ecosystem class to which it has been assigned, within a drainage division.

While these guidelines were developed to identify high ecological value aquatic ecosystems at a national level (drainage division scale) they can be used at a range of scales and were therefore adapted where appropriate (e.g. incorporating results of sampling parameters and river bio-assessment scores) to suit the purposes of this assessment as per advice in the guidelines.

Table 2.1 Criteria used to assess aquatic ecosystem value

Criteria [a]	Low	Moderate	High
Diversity	Low biodiversity of aquatic flora and fauna Low habitat diversity Poor to fair habitat bio-assessment scores	Moderate to good biodiversity of aquatic flora and fauna Fair habitat diversity Good habitat bio-assessment scores	High biodiversity of aquatic flora and fauna High habitat diversity Good to very good bio-assessment scores
Distinctiveness	Species, communities and processes common Available habitat types common No habitat for protected species	Species, communities and processes moderately common Available habitat types relatively common	Species, communities and processes rare Available habitat types rare Core habitat for protected species

Criteria [a]	Low	Moderate	High
	No listed protected aquatic areas, habitats or species High tolerance to change or highly adaptive communities	No core habitat for protected species Listed protected aquatic areas, habitats or species, but unlikely to provide significant habitat (e.g. breeding area) Moderate tolerance to change or moderately adaptive communities	Listed protected aquatic areas, habitats or species Sensitive or poorly adaptive communities
Vital Habitat	Poor refuge or breeding area Supports low numbers of native species Little fisheries value Poor connectivity and fish passage	Limited refuge or breeding area Supports moderate numbers of native species Moderate fisheries value Limited connectivity and fish passage	Important refuge or breeding area Supports high numbers of native species High fisheries value High connectivity and important corridor for fish passage
Naturalness	Highly disturbed Poor riparian condition Poor habitat condition	Moderately disturbed Moderate to good riparian condition Moderate to good habitat condition	Undisturbed, pristine Excellent riparian condition Excellent habitat condition
Representativeness	Highly disturbed Poor example of ecosystem type	Moderately disturbed Average example of ecosystem type	Undisturbed Outstanding example of ecosystem type

[a] Source: Aquatic Ecosystems Task Group 2012

2.2 Stygofauna

2.2.1 Pilot Study

A stygofauna (i.e. subterranean aquatic fauna) pilot study has been competed for the Project by Freshwater Ecology over two sampling events in November 2020 and May 2021 (Freshwater Ecology 2021; refer to **Attachment B** for details). Bores surveyed for stygofauna are shown in **Figure 2.1**. Two bores were intended to be surveyed but were not surveyed as they were dry during both sampling events. As such, a total of eight bores were sampled in the pilot study. The results of this pilot study have been used to summarise stygofauna communities of the Project area and surrounds, along with a desktop assessment (as outlined below in **Section 2.2.2**).

2.2.2 Desktop Assessment

A desktop assessment of stygofauna in accordance with the *Guideline for the Environmental Assessment of Subterranean Aquatic Fauna* (DSITI 2015) was conducted to:

- assess the suitability of local habitat for stygofauna based on the hydrogeology in the vicinity of the Project; and
- assess the likely presence and composition of stygofauna in the vicinity of the Project.

The desktop review summarised existing general information available on stygofauna and habitat preference in Australia and Queensland, including:

- the Queensland Subterranean Aquatic Fauna Database curated by the Queensland Herbarium (DES 2023c);
- results from stygofauna assessments completed as part of EIS projects for other coal mines in the region, including Caval Ridge Mine Horse Pit Extension Project (ESP 2021), Ensham Life of Mine Extension Project (frc environmental 2020), Minyango Project (State of Queensland 2014), and Washpool Coal Mine Project (State of Queensland 2012);
- scientific publications, including the CSIRO report to the Australian Coal Association Research Program (ACARP) on the extent of knowledge of Stygofauna in Australian Groundwater Systems (Hose et al 2015); and
- groundwater assessments completed for the Project, including the *Groundwater Modelling Technical Report* (SLR 2023b) and *Groundwater Impact Assessment* (SLR 2023c).

3 Aquatic Ecological Values of the Existing Environment

3.1 Aquatic Habitat

3.1.1 Waterways

Natural waterways in the region are typically temporary or ephemeral streams, which are dry for most of the year and flow for a short time following rainfall events that are more common in the wet season. The wet season also has the highest evaporation rates and potential evaporation consistently far exceeds rainfall during all seasons (SLR 2023a), leading to dry conditions. Intermittent pools that persist for several months may be present in certain reaches of these ephemeral waterways, particularly where clay substrates dominate the bed. During the dry season, larger permanent waterholes provide a refuge for aquatic flora and fauna.

Land use within the Mackenzie River sub-basin is primarily grazing, but there are also many coal mines and a large area of irrigated and dry land cropping (Rollason & Howell 2012). Flows in the catchment are highly regulated in some sections, controlled by Bingegang, Bedford and Tartus weirs, as well as several water harvesting operations.

The condition of freshwater habitats in the Mackenzie River sub-basin is monitored through the Ecosystem Health Index Reports, coordinated by the Fitzroy Partnership for River Health (FPRH). Report cards summarising the monitoring results are published annually, with grades ranging from ‘A’ to ‘E’ depending on a range of categories relating to the environmental health of the waterways (including physical/chemical, nutrients, toxicants and ecology) (FPRH 2023). Monitoring carried out in 2021–2022 concluded that the Mackenzie River sub-basin had an overall environmental condition grading of ‘C’ (i.e. fair), which was similar to all previous monitoring periods since monitoring commenced in 2010–2011, except for the monitoring period in 2013–2014, which had a grading of ‘B’ (i.e. good) (FPRH 2023). The grading of ‘C’ in 2021–2022 was attributed to (FPRH 2023):

- good to excellent physicochemical water quality, except for turbidity which was fair;
- good nutrient concentrations;
- good to excellent concentrations of most metals and metalloids, except for concentrations of copper and aluminium which were fair; and
- poor to very poor (fail) condition of macroinvertebrate communities with low taxonomic richness and richness of sensitive taxa.

These results are consistent with the desktop ACA assessment for the riverine wetlands of the Great Barrier Reef catchment (Inglis & Howell 2009), which classified most waterways within the sub-basin as ‘moderate’ conservation significance in accordance with the Aquatic Biodiversity Assessment and Mapping Method (AquaBAMM) (Clayton et al 2006). Within the Project area and downstream, waterways were classified as either ‘very low’ (Taurus Creek and its tributaries, as well as lacustrine waterbodies, where mapped) or ‘moderate’ (Sagittarius and Blackwater creeks and most of their tributaries) conservation significance.

Waterways within the Project area predominantly minor ephemeral waterways classified as stream order one and two, although there are sections of stream order three and four

waterways in the eastern and southern sections of the Project area associated with Two Mile Gully, Taurus Creek and Sagittarius Creek. Downstream of the Project area, Blackwater Creek is a stream order five at the confluence with Taurus Creek.

Physical habitat is also monitored as part of the BWM REMP, though due to the ephemeral nature of waterways in the region, sites are often dry. Aquatic habitat condition in Blackwater, Deep and Taurus Creeks has varied from poor to good since monitoring commenced in 2011. In Blackwater Creek upstream and downstream of BWM, riparian vegetation and bank stability were typically in good condition (although some bare and eroded areas were evident), and sites typically consisted of stagnant pools with limited scouring and deposition (Gauge Industrial & Environmental 2021; Gauge Industrial & Environmental 2021; Gauge Industrial & Environmental 2023, Hydrobiology 2019). In Deep Creek upstream of BWM, bank stability was good, and there was limited scouring and deposition in the stagnant pools. Rockland Creek upstream of BWM was typically in good condition, due to minimal channel alteration, scouring and deposition of fine sediment, although streamside vegetation cover and diversity of flow types were limited. There was no notable difference in physical habitat conditions between sites upstream and downstream of BWM. Most sites had moderate bank stability (adversely impacted in some areas by livestock access and vegetation clearing), substrate dominated by fine silts and sands, and riparian zone consisting largely of shrubs and grasses (with few mature trees) (Hydrobiology 2019). Overall, results from the REMP indicated that all waterways surveyed in the vicinity of BWM contained sufficient structural complexity to provide moderately diverse biological (macroinvertebrate) communities in the presence of sufficient water.

Aquatic habitat assessments completed at sites within the Project area for the baseline aquatic ecology assessment showed that physical habitat conditions were generally poor to fair (EMM 2023a). The availability of bottom substrates was poor to fair (mostly fine sediments with a lack of pebbles, cobbles and boulders). Most sites had some instream structural complexity which provided habitat and refuge for aquatic fauna, such as detritus and woody debris. Although most sites were impacted by cattle grazing, the riparian zone was typically in good condition, with vegetation dominated by trees covering at least 50% of the banks at most sites. Some areas of erosion were evident on the banks. Most sites were dry or consisted of disconnected pools during the field survey. This is reflective of the ephemeral nature of waterways in the region, which typically flow for short periods during high rainfall events, before receding to shallow pools. The overall aquatic habitat was assessed as low to moderate for riverine sites (EMM 2023a).

3.1.2 Lacustrine Wetlands and Farm Dams

As outlined in **Section 1.3.2**, there are several State mapped lacustrine wetlands and unmapped farm dams within and in the vicinity of the Project (refer to **Figure 1.2**). One mapped lacustrine wetland on a tributary of Two Mile Gully (site L2 on **Figure 2.1**) and one unmapped farm dam on Sagittarius Creek (site L1 on **Figure 2.1**), both modified by the presence of a dam for agriculture / stock watering, were assessed during the baseline field surveys (EMM 2023a). The mapped lacustrine wetland on Two Mile Gully is located on an adjacent tributary to the Project footprint and the farm dam on Sagittarius Creek is located approximately 1.5 km downstream of the Project footprint.

Aquatic habitats assessed at the two lacustrine wetland sites were comparable during the baseline aquatic ecology field surveys, both consisting of shallow and deep pools (EMM 2023a). Instream sediments consisted of fine silt / clay. The sites typically contained moderately abundant and diverse aquatic plant communities, including floating and submerged species, indicating that they hold water for extended periods and provide relatively favourable conditions for aquatic flora. These sites were impacted by moderate cattle grazing and the land was predominantly cleared of native vegetation. Although connectivity to downstream habitats was typically limited due to the construction of dam walls, these sites would likely provide dry season refuges for aquatic flora and fauna, providing moderate value habitat to aquatic flora and fauna (EMM 2023a).

While assessed as providing moderate value habitat during surveys by EMM (2023a), all wetlands in the vicinity of the Project (including one of those assessed by EMM 2023a) were classified as having “very low” conservation value in the ACA assessments of non-riverine wetlands (in accordance with the AquaBAMM; Clayton et al 2006, Rollason and Howell 2012). This was due to low diversity, richness, and naturalness criteria.

3.1.3 Palustrine Wetlands

As outlined in **Section 1.3.2**, there are no mapped palustrine wetlands within the Project area.

There are two small mapped palustrine wetlands in close proximity to the Project area, one on Two Mile Gully upstream and approximately 1.5 km east of the Project area, and one on Deep Creek upstream and approximately 6 km west of the Project area (refer to **Figure 1.2**). These were classified as having “moderate” conservation value in the ACA assessments of non-riverine wetlands (in accordance with the AquaBAMM; Clayton et al 2006, Rollason and Howell 2012). This was due to low aquatic naturalness; moderate catchment naturalness, diversity and richness criteria; and high threatened species / priority species and ecosystems criteria.

3.2 Water Quality

3.2.1 Environmental Values

The quality of natural waters in Queensland is protected under the EPP (Water and Wetland Biodiversity). The EPP (Water and Wetland Biodiversity) outlines the EVs that may apply to waters in Queensland. For the aquatic ecosystem EV, it also describes various levels of protection and associated WQOs, including for HEV, slightly disturbed, moderately disturbed and highly disturbed waters.

The waterways in the vicinity of the Project are within the Mackenzie southern tributaries sub-catchment under Schedule 1 of the EPP (Water and Wetland Biodiversity) (DEHP 2013; DSITI 2017). Updated draft guidelines for the Fitzroy Basin are also available (DSITI 2017). These have been reviewed in the *Surface Water Impact Assessment* completed for the Project, with the following EVs considered relevant to the Project area (SLR 2023a):

- aquatic ecosystems (moderately disturbed);
- farm supply / use;

- stock water;
- visual recreation; and
- cultural and spiritual use.

Although the EV for human consumption is listed for this area of the sub-basin in DEHP 2013, it is not considered relevant for the Project area due to the ephemeral nature of the creeks and lack of any water supply infrastructure in close proximity the Project (SLR 2023a). It is also considered unlikely that waterways will be used for primary or secondary recreation due to the ephemeral nature of the watercourses and their location (SLR 2023a).

There are no HEV waterways or wetlands within the Project footprint or downstream waterways in the Mackenzie River sub-basin.

3.2.2 Water Quality

Water quality in the Mackenzie River sub-basin can be highly variable over time, primarily due to the ephemeral nature of the waterways. Long term trends in water quality of the Mackenzie River sub-basin from monitoring carried for the Ecosystem Health Index Report indicated physicochemical water quality and nutrients are typically good, although turbidity is often poor to fair and electrical conductivity, oxidised nitrogen, total nitrogen and filterable reactive phosphorus are fair at times. Metals and metalloids are typically good to excellent, except for copper and aluminium, which are often poor to fair (FPRH 2023). The most recent water quality results in 2021–2022 indicated water quality had improved since the previous monitoring period and was generally good to excellent, characterised by good to excellent physicochemical water quality (except for turbidity which was frequently high), good nutrient concentrations, and relatively low concentrations of most metals and metalloids (except for concentrations of copper and aluminium which were occasionally high) (FPRH 2023).

There are three Queensland Government surface water quality monitoring stations on the Mackenzie River (State of Queensland 2023):

- Riley's crossing, approximately 55 km upstream of the confluence with Blackwater Creek (station 130113A), data available between July 2008 and June 2023;
- Bingegang, approximately 50 km downstream of the confluence with Blackwater Creek (station 130106A), data available between November 1971 and March 2023; and
- Coolmaringa, adjacent tributary approximately 80 km northeast of the Project (station 130105B), data available between April 2018 and May 2023.

Results from these surface water quality monitoring stations on the Mackenzie River showed:

- neutral pH, with median values within the WQO range;
- high electrical conductivity upstream (median above the WQO) at station 130113A, but lower levels downstream of the confluence of Blackwater Creek and on the adjacent tributary (median below the WQO);
- variable dissolved oxygen, with low concentration measured at times at all stations;
- variable concentrations of nutrients, although the median total nitrogen and total phosphorus were below the WQOs; and

- low concentrations of most metal parameters, although concentrations of aluminium, cadmium, chromium, cobalt, vanadium and zinc were generally highest downstream of the confluence of Blackwater Creek (where the median concentration was above the WQO).

Results from water quality surveys recently completed at sites on Burngrove, Blackwater, Sirius and Rockland creeks as part of the BWM REMP are generally consistent with results from the broader region. Overall, water quality during sampling completed from 2017 to 2022 showed (Gauge Industrial & Environmental 2020, 2021, 2023; Hydrobiology 2019):

- neutral pH, typically within the REMP WQO range;
- electrical conductivity typically below the REMP WQO of 2,000 µS/cm (although above the drinking water quality guideline, this EV does not apply to these waterways);
- variable dissolved oxygen, frequently outside of the REMP WQO range;
- high total suspended solids, typically above the REMP WQO;
- low concentrations of ions, typically below the REMP WQOs (where available for the concentrations of sulfate and fluoride);
- high concentrations of some nutrients, including ammonia, total nitrogen and total phosphorus, which were typically above the REMP WQOs; and
- low concentrations of most metal parameters, although concentrations of dissolved copper, and total aluminium, iron and manganese can be high at times.

Results from the REMP generally indicate that where concentrations of analytes are above the REMP WQOs, this generally occurred both upstream and downstream of the BWM. Overall, REMP monitoring indicates changes in water quality are within acceptable limits and/or downstream medians were within guideline values, suggesting the current EA limits are protecting the receiving environment (Gauge Industrial & Environmental 2022).

Water quality data for pH and electrical conductivity regularly sampled during periods of flow at key upstream and downstream flow monitoring locations since 2013 indicated that the pH is generally within the WQO range, and that electrical conductivity is generally below the 2,000 µS/cm requirements for downstream waters under the EA (SLR 2023a).

Physiochemical water quality and major ions were assessed at one riverine (site R4), one riverine wetland (site RW1) and two lacustrine (farm dam) wetlands (sites L1 and L2) sites in the baseline aquatic ecology assessment for the Project (EMM 2023a; refer to **Figure 2.1** for location of sites). The remaining sites were not sampled as they were dry during both sampling events. Overall, water quality results indicated (EMM 2023a):

- mildly to strongly alkaline (ranging from pH 7.6 to 8.6) and exceeded the WQO at times;
- relatively high electrical conductivity (generally ranging from 387 to 676 µS/cm) that was above the WQO of 310 µS/cm but generally indicative of freshwaters (<800 µS/cm), except at the farm dam on Two Mile Gully in May 2020 (2,401 mS/cm), which had an electrical conductivity indicative of brackish waters;

- variable dissolved oxygen concentration (ranging from 20 to 89 % saturation) that was below the WQO range;
- moderate to high turbidity (ranging between 24 to 41 NTU) that exceeded the WQO at the lacustrine wetland sites;
- hardness (ranging between 95 to 193 mg/L) generally indicating moderate to extremely hard waters, although was extremely hard (634 mg/L) at the farm dam on Two Mile Gully in May 2020; and
- ion concentrations generally indicative of bicarbonate waters, typical of surface waters where catchment soils or geology are the main source of dissolved material (i.e. the dissolution of soil/rock is the major process controlling surface water chemistry, rather than atmospheric precipitation or evaporation/crystallization). The exception was elevated levels of sulphate, and to a lesser extent sodium and chloride, at the farm dam on Two Mile Gully in May 2020.

3.3 Sediment Quality

Sediment quality in the vicinity of BWM is routinely monitored as part of the REMP. Recent sediment sampling in sampling in 2017 / 2018 (Hydrobiology 2019), 2019 / 2020 (Gauge Industrial & Environmental 2020), 2020 / 2021 (Gauge Industrial & Environmental 2021) and 2021-2022 (Gauge Industrial & Environmental 2023) showed that sediment quality in waterways in the vicinity of BWM (including Blackwater, Burngrove, Rockland, Deep and Sirius creeks) was generally good when compared with background concentrations, and characterised by:

- bed sediments dominated by fine particles, including silt, clay and sand, with small amounts of gravel; and
- low concentrations of metals, typically below the relevant default guideline values (DGVs), or less than two times greater than concentrations at respective control sites (for parameters where no DGV was available).

Concentrations of some metals, including nickel and iron, were slightly elevated (though still not likely to have impacted aquatic biological communities) at sites throughout the region. No consistent trend in concentrations of these metals was evident between sites upstream and downstream of BWM, indicating that they were unlikely to be a result of mining operations at BWM. Sediment quality was likely influenced to some degree by surrounding land-use and local geomorphology, which is characteristic of a moderately disturbed system.

3.4 Aquatic Plants

Aquatic plant communities of the Fitzroy River basin are generally sparse with a low diversity of species, which has been attributed to the naturally harsh environmental conditions of ephemeral waterways (Negus 2007). Across the Mackenzie River sub-basin, 103 aquatic plant species (i.e. species listed as wetland indicator species) have been recorded, none of which are listed as threatened under State or Commonwealth legislation (DES 2013a). Twenty-two wetland indicator species listed as special least concern under the NC Act have been recorded.

There are no published records of any aquatic plant species listed as near threatened, vulnerable, endangered or critically endangered under the NC Act or the EPBC Act within 20 km or 50 km of the Project footprint (DCCEEW 2023a, DES 2023a, EMM 2023b, c).

In the aquatic ecology baseline surveys for the Project, 21 native aquatic or semi-aquatic plant species were recorded from within the Project area (EMM 2023a). Emergent growth forms, namely sedges (*Cyperus* spp.), dominated plant communities, with submerged and floating species only recorded from farm dams. Sites on smaller tributaries typically contained no aquatic plants. In-stream aquatic plant coverage and diversity was low at most sites except farm dams, reflecting the ephemeral nature of the waterways in the region as well as impacts from cattle grazing and trampling (EMM 2023a). Three species listed as priority flora in the Fitzroy River ACA were found:

- tall flatsedge (*Cyperus exaltatus*) in low cover at riverine sites on Sagittarius and Taurus creeks and well as at a farm dam site on Sagittarius Creek;
- water snowflake (*Nymphoides indica*) in low cover in December 2019 and moderate cover in May 2020 at a farm dam site on Two Mile Gully; and
- swamp lily (*Ottelia ovalifolia*) in low cover at a farm dam site on Sagittarius Creek.

These species are priority species as they can form significant macrophyte beds providing important habitat and source of food for fauna species (Rollason and Howell 2012). No listed threatened aquatic plant species were recorded during the baseline surveys (EMM 2023a).

Four introduced aquatic plant species have been recorded from the Mackenzie River sub-basin (DES 2013a):

- white eclipta (*Eclipta prostrata*);
- water couch (*Paspalum distichum*);
- umbrella sedge (*Cyperus involucratus*); and
- awnless barnyard grass (*Echinochloa colona*).

None of these species are WoNS or listed as prohibited or restricted matters under the *Biosecurity Act 2014.* White eclipta and awnless barnyard grass were recorded in the Sagittarius Creek catchment and the Two Mile Gully catchment (white eclipta only) during baseline aquatic ecology surveys for the Project (EMM 2023a).

3.5 Aquatic Macroinvertebrates

Macroinvertebrate communities in the Mackenzie River sub-basin are monitored as part of the Ecosystem Health Index Report. Results from 2019 to 2022 concluded that macroinvertebrate communities were in poor condition, with a low diversity of taxa (FPRH 2022). Macroinvertebrate communities typically consisted of common taxa that are tolerant to harsh environmental conditions, with few sensitive Plecoptera, Ephemeroptera and Trichoptera (PET) taxa present and low Stream Invertebrate Grade Number – Average Level (SIGNAL) grades recorded.

Macroinvertebrate communities in Burngrove, Blackwater, Sirius and Rockland creek catchments in the vicinity of the Project are routinely monitored as part of the BWM REMP. Sampling from 2011 to 2022 showed that the condition of macroinvertebrate communities is

highly variable over time, and monitoring sites are often dry (Hydrobiology 2016, 2019; Gauge Industrial & Environmental 2013, 2014, 2017, 2020, 2021, 2023). Historically, indices recorded for macroinvertebrate communities in the vicinity of BWM have generally been within or below the biological objectives outlined in the EPP (Water and Wetland Biodiversity) (Gauge Industrial & Environmental 2021, Hydrobiology 2019). Macroinvertebrates in bed (pool) habitat were typically in moderate condition, with diverse communities consisting of tolerant and common taxa; taxonomic richness and PET richness were generally within the biological objectives, however SIGNAL2 scores were generally below the biological guidelines. Macroinvertebrate communities in edge habitat were typically in poor condition; taxonomic richness, PET richness and SIGNAL2 scores were generally below the biological guidelines. Communities were typically dominated by common taxa that are tolerant of harsh physical conditions. There was no indication that mining was having a negative influence on the health of macroinvertebrate communities. Macroinvertebrate communities at sites downstream of BWM on higher stream orders were often in better condition (with indices equal to or exceeding the guideline) than those upstream (Gauge Industrial & Environmental 2021, Hydrobiology 2019).

During the baseline aquatic ecology surveys, macroinvertebrate samples were collected from a riverine and floodplain site on Taurus Creek (sites R4 and RW1; refer to **Figure 2.1**) as well as a farm dam on Sagittarius Creek (site L1; refer to **Figure 2.1**) (EMM 2023a). A total of 40 taxa were recorded during the surveys, with communities dominated by a range of true bug (Hemiptera), true fly (Diptera) and beetle (Coleoptera) families. All of these taxa are common in the region and are considered to be tolerant to a range of environmental conditions (where sensitivity ratings are available). Overall, macroinvertebrate communities during baseline surveys were in poor to moderate condition. Taxonomic richness was moderate in bed samples and low in edge samples, and was within or below the biological objectives outlined in the EPP (Water and Wetland Biodiversity) at most sites (EMM 2023a). Few sensitive taxa were recorded, indicating that environmental conditions are harsh and more suitable for tolerant taxa. Results indicated unfavourable physical conditions and / or reduced habitat quality, likely reflecting seasonality and the ephemeral nature of waterways in the region, rather than catchment impacts (EMM 2023a). No threatened macroinvertebrate taxa were recorded or are known from the Fitzroy River basin or Mackenzie River sub-basin (DES 2023a, b; EMM 2023a).

3.5.1.1 Macrocrustaceans

While there is limited data on macrocrustaceans in the Project area, decapoda (yabby, river prawns and glass shrimp) were recorded in the baseline surveys for the Project (EMM 2023a) and have been recorded previously in the region, including freshwater prawns (*Macrobrachium* sp.) and common yabby (*Cherax destructor*) (DES 2023a). No threatened macrocrustaceans have been recorded or are known from the Fitzroy River basin or Mackenzie River sub-basin (DES 2023a, b; EMM 2023a).

3.6 Aquatic Vertebrates

3.6.1 Fish

There are 29 native fish species known from the waterways of the Mackenzie River sub-basin (**Table 3.1**). These species typically have a wide range of habitat preferences (e.g.

smaller drainage lines, larger rivers and wetlands) and are tolerant of a range of water quality conditions (pH, salinity and dissolved oxygen concentrations). Of these taxa, three are considered endemic to the Fitzroy region: southern saratoga (*Scleropages leichardti*), leathery grunter (*Scortum hilli*) and golden perch (*Macquaria ambigua*) (Platten 2011).

Six exotic fish have been previously recorded in the Fitzroy Basin (DES 2013b). One exotic fish has been recorded in the Mackenzie River sub-basin (DES 2013a), mosquitofish (*Gambusia holbrooki*). However, tilapia (*Oreochromus mossambicus*) has also been recorded in waterways within the region during previous surveys (Catchment Solutions 2015, FBA 2017). These species are restricted noxious fish under the *Biosecurity Act 2014.*

Two threatened species of fish listed under the EPBC Act were identified as possibly occurring in the Mackenzie River sub-basin: silver perch and Murray cod. The habitat preferences and ecology of these species are discussed in **Section 3.9**.

During aquatic ecology baseline surveys, nine species of native fish were recorded at riverine and floodplain sites on Taurus Creek (sites R4 and RW1; refer to **Figure 2.1**) and a farm dam site on Sagittarius Creek (site L1; refer to **Figure 2.1**) (EMM 2023a; **Table 3.1**). All species were considered common to the Mackenzie River sub-basin, with no listed threatened species recorded. One exotic species, mosquitofish, was recorded in the farm dam on Sagittarius Creek. Fish communities were dominated by small bodied species, with the lack of large-bodied fish likely due to the paucity of deep pool habitat. The abundance of fish varied seasonally, with higher numbers of individuals caught in the late-wet season survey (when aquatic habitat availability and diversity was higher) than during the early-wet season survey.

Table 3.1 Freshwater fish recorded from the region

Family *Species Name*	Common Name	Fitzroy River Basin [a]	Mackenzie River Sub-Basin [b]	Project Area [c]
Ambassidae				
Ambassis agassizii	Agassiz's glassfish	Yes	Yes	Yes
Anguillidae				
Anguilla reinhardtii	longfin eel	Yes	Yes	No
Apogonidae				
Glossamia aprion	mouth almighty	Yes	Yes	No
Ariidae				
Neoarius graeffei	blue catfish	Yes	Yes	No
Atherinidae				
Craterocephalus marjoriae	silverstreak hardyhead	Yes	No	No
Craterocephalus stercusmuscarum	flyspecked hardyhead	Yes	Yes	Yes
Belonidae				
Strongylura krefftii	freshwater longtom	Yes	Yes	No
Centropomidae				
Lates calcarifer	barramundi	Yes	Yes	No
Ceratodontidae				
*Neoceratodus forsteri***	Australian lungfish	Yes	No	No
Cichlidae				

Family *Species Name*	Common Name	Fitzroy River Basin [a]	Mackenzie River Sub-Basin [b]	Project Area [c]
*Oreochromis mossambicus***	tilapia	Yes [d]	Yes [g]	No
Clupeidae				
Nematalosa erebi	bony bream	Yes	Yes	Yes
Cyprinidae				
*Carassius auratus**	goldfish	Yes	No	No
*Cyprinus carpio***	European carp	Yes	No	No
Eleotridae				
Gobiomorphus australis	striped gudgeon	Yes	No	No
Hypseleotris compressa	empire gudgeon	Yes	Yes	No
Hypseleotris galii	firetail gudgeon	Yes	Yes	No
Hypseleotris klunzingeri	western carp gudgeon	Yes	Yes	Yes
Hypseleotris spp.	common carp gudgeon	Yes	Yes	Yes
Mogurnda adspersa	southern purple-spotted gudgeon	Yes	Yes	Yes
Oxyeleotris aruensis	Aru gudgeon	Yes	No	No
Oxyeleotris lineolata	sleepy cod	Yes	Yes	No
Philypnodon grandiceps	flathead gudgeon	Yes	Yes	No
Gobiidae				
Redigobius bikolanus	speckled goby	Yes	No	No
Hemiramphidae				
Arrhamphus sclerolepis	snubnose garfish	Yes	No	No
Megalopidae				
Megalops cyprinoides	oxeye herring	Yes	Yes	No
Melanotaeniidae				
Melanotaenia splendida splendida	eastern rainbowfish	Yes	Yes	Yes
Rhadinocentrus ornatus	ornate rainbowfish	Yes	No	No
Mugilidae				
Mugil cephalus	sea mullet	Yes	No	No
Trachystoma petardi	freshwater mullet	Yes	No	No
Osteoglossidae				
Scleropages leichardti	southern saratoga	Yes	Yes	No
Percichthyidae				
*Maccullochella peelii****	Murray cod	Yes	No	No
Macquaria ambigua	golden perch	Yes	Yes	No
Plotosidae				
Neosilurus ater	black catfish	Yes	Yes	No
Neosilurus hyrtlii	Hyrtl's catfish	Yes	Yes	Yes
Porochilus rendahli	Rendahl's tandan	Yes	No	No
Tandanus tandanus	freshwater catfish	Yes	Yes	No
Poeciliidae				
*Gambusia holbrooki***	mosquitofish	Yes	Yes	Yes
*Poecilia reticulata**	guppy	Yes	No	No
*Xiphophorus maculatus**	platy	Yes [d]	No	No

Family *Species Name*	Common Name	Fitzroy River Basin [a]	Mackenzie River Sub-Basin [b]	Project Area [c]
Pseudomugilidae				
Pseudomugil signifer	Pacific blue eye	Yes	Yes	No
Retropinnidae				
Retropinna semoni	Australian smelt	Yes	No	No
Scorpaenidae				
Notesthes robusta	bullrout	Yes	Yes	No
Terapontidae				
Amniataba percoides	barred grunter	Yes	Yes	No
*Bidyanus bidyanus***	silver perch	Yes	Yes [e]	No
*Hephaestus fuliginosus*****	sooty grunter	Yes	Yes [f]	No
Leiopotherapon unicolor	spangled perch	Yes	Yes	Yes
Scortum hillii	leathery grunter	Yes	Yes	No
Terapon jarbua	crescent grunter	Yes	No	No
Total No. Native Species		**42**	**29**	**9**
Total No. Exotic Species		**6**	**2**	**1**

* indicates introduced species
** indicates restricted noxious pest species under the *Biosecurity Act 2014*
*** indicates listed threatened species under the EPBC Act
**** indicates native species that is considered a pest in the Mackenzie River sub-basin
[a] Source: DES 2013b
[b] Source: DES 2013a
[c] Source: EMM 2023a
[d] Source: Catchment Solutions 2015
[e] Source: ALA 2023
[f] Source: Platten 2011
[g] Source: FBA 2017

3.6.2 Turtles

Six species of native freshwater turtles are known to occur in the Mackenzie River sub-basin (DES 2013a):

- broad-shelled river turtle (*Chelodina expansa*);
- eastern snake-necked turtle (*Chelodina longicollis*);
- Krefft's river turtle (*Emydura macquarii krefftii*);
- saw-shelled turtle (*Myuchelys latisternum*);
- white-throated snapping turtle; and
- Fitzroy River turtle.

The broad-shelled river turtle, eastern snake-necked turtle, Krefft's river turtle and saw-shelled turtle are widely distributed on the east coast of Australia in rivers and wetlands. These turtle species are not listed under the EPBC Act and are listed as least concern under the NC Act.

One eastern snake-necked turtle was recorded in a farm dam on Sagittarius Creek (site L1; refer to **Figure 2.1**) during the early-wet season baseline field survey (EMM 2023a). Turtles

were not particularly abundant or widespread throughout the waterways within the Project area during the surveys, which is likely a reflection of the ephemeral nature of the region, where only isolated pools persist year-round and act as refugia for turtles.

The white-throated snapping turtle is listed as critically endangered under the EPBC Act and endangered under the NC Act, while the Fitzroy River turtle is listed as vulnerable under both the EPBC Act and the NC Act. Their preferred habitat, distribution and ecology is discussed in **Section 3.8.2.1**.

3.6.3 Platypus

Platypus have been recorded in the Mackenzie River sub-basin (DES 2013a) and are protected as 'Special Least Concern' under the NC Act. Their preferred habitat, distribution and ecology is discussed in **Section 3.8.2.2**.

3.7 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 for maintenance of the ecosystem (Richardson et al 2011). GDEs are classified by Doody et.al. (2019) into three broad types:

- ecosystems dependent on the surface-expression of groundwater (i.e. aquatic GDEs)
- aquifer and cave ecosystems (i.e. subterranean GDEs), and
- ecosystems dependent on the subsurface presence of groundwater (i.e. terrestrial GDEs, including some riparian vegetation communities).

The sub-sections below provide an assessment of the potential occurrence of aquatic GDEs and of subterranean GDEs (stygofauna) in the area surrounding the Project. The terrestrial ecology assessments for the Project provides an assessment of terrestrial GDEs (EMM 2023b, c).

3.7.1 Surface-expression GDEs

Aquatic GDEs in freshwater environments are classified as either (Doody et al 2019):

- river baseflow systems (i.e. aquatic and riparian ecosystems that exist in or adjacent to streams which are fed by groundwater), or
- wetlands (i.e. aquatic communities and fringing vegetation dependent on groundwater fed lakes and wetlands, such as palustrine and lacustrine wetlands that receive groundwater discharge, and can include spring and swamp ecosystems).

Desktop mapping of potential aquatic GDEs in Queensland shows no known or derived surface-expression GDEs within the Project area (BOM 2023, Queensland Government 2023, EMM 2023a). Furthermore, baseline field surveys of waterways and wetlands within the Project area concluded that no obvious signs of groundwater influence were evident, based on the concentration and relative proportion of major ions in surface water samples (EMM 2023a). In addition, surveys in December 2019 were undertaken following a prolonged dry period providing ideal conditions for identifying aquatic GDEs, however, no flows, salt seeps, hydrophytes or other obvious indicators of aquatic GDEs were encountered (EMM 2023a).

There are no known aquatic GDEs mapped in the vicinity of the Project. There is a very small low potential GDE mapped on Deep Creek (approximately 6 km west of the Project). One aquatic system to the northeast and downstream of the Project area is mapped as having moderate potential for groundwater interaction (**Figure 3.1**). This system includes a section of Blackwater Creek approximately 10 km downstream of the Project area. The desktop ACA assessment for the riverine wetlands of the Great Barrier Reef catchment (Inglis and Howell 2009) classified this section of Blackwater Creek as having 'moderate' conservation significance (in accordance with the Aquatic Biodiversity Assessment and Mapping Method (AquaBAMM); Clayton et al 2006). This classification was based on:

- a low score for aquatic naturalness;
- medium scores for catchment naturalness, diversity and richness, and connectivity; and
- high scores for threatened / priority species and ecosystems.

The tributaries of Blackwater Creek that also form part of the potential surface-expression GDE system were classified as having 'very low' conservation significance, based on:

- a low score of aquatic naturalness;
- a high score for catchment naturalness;
- medium scores for diversity and richness, and connectivity; and
- no data for threatened / priority species and ecosystems.

3.7.2 Subterranean GDEs

There are no potential subterranean GDEs mapped within or in the vicinity of the Project area. The results of the stygofauna assessment are presented in **Section 4**.

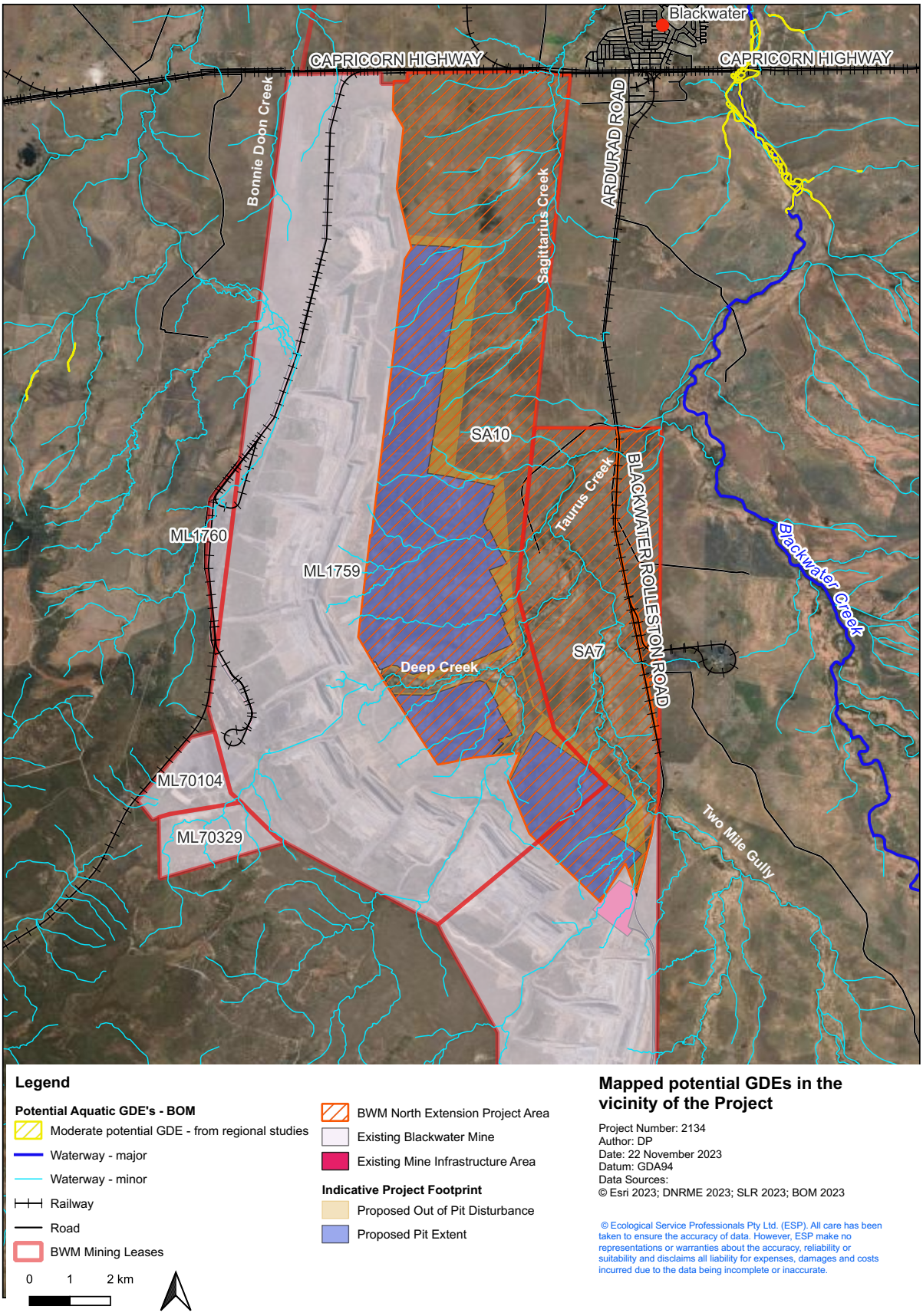

Figure 3.1 Mapped potential GDEs in the vicinity of the Project

3.8 Matters of State Environmental Significance

Several MSES relevant to aquatic ecology occur or have the potential to occur in the vicinity of the Project, including:

- waterways providing for fish passage; and
- listed species.

These matters are discussed in more detail in the sections below. No other aquatic MSES (including HEV waterways or HES / WPA wetlands) occur in the vicinity of the Project (EMM 2023b).

3.8.1 Waterways Providing for Fish Passage

Many species of native fish known from the region migrate upstream and downstream, and between different aquatic habitats, at different stages of their life cycle (Marsden & Power 2007). Stimuli for movement include small and large flow events and increases in water temperature. Spring and summer are generally the most important months for migration; however, maintaining fish passage is important throughout the year (Marsden & Power 2007). The waterways in the vicinity of the Project provide temporary habitat and aquatic fauna movement corridors during flow events.

The Department of Agriculture and Fisheries (DAF) *Queensland Waterways for Waterway Barrier Works* mapping indicates the level of 'risk' associated with undertaking waterway barrier works within Queensland waterways with regards to fish passage (DAF 2023). This dataset represents pre-development conditions, and shows waterways which have been affected by mining activities in the region (and therefore does not reflect the current locations of waterways in the area in some instances).

Where the works associated with the Project are undertaken on the mining lease under the conditions of an EA (and not a development approval), a waterway barrier works approval under the Fisheries Act will not be required; however, fish passage requirements in the Project area, and in upstream and downstream waterways, need to be considered and assessed as a MSES. Within and in the vicinity of the Project area (**Figure 3.2**):

- Two Mile Gully, Taurus Creek and Blackwater Creek are mapped as major risk (purple);
- Deep Creek and Sagittarius Creeks are mapped as moderate risk (amber) to high risk (red);
- Other mapped upstream waterways within the Project area are low (green) to moderate (amber).

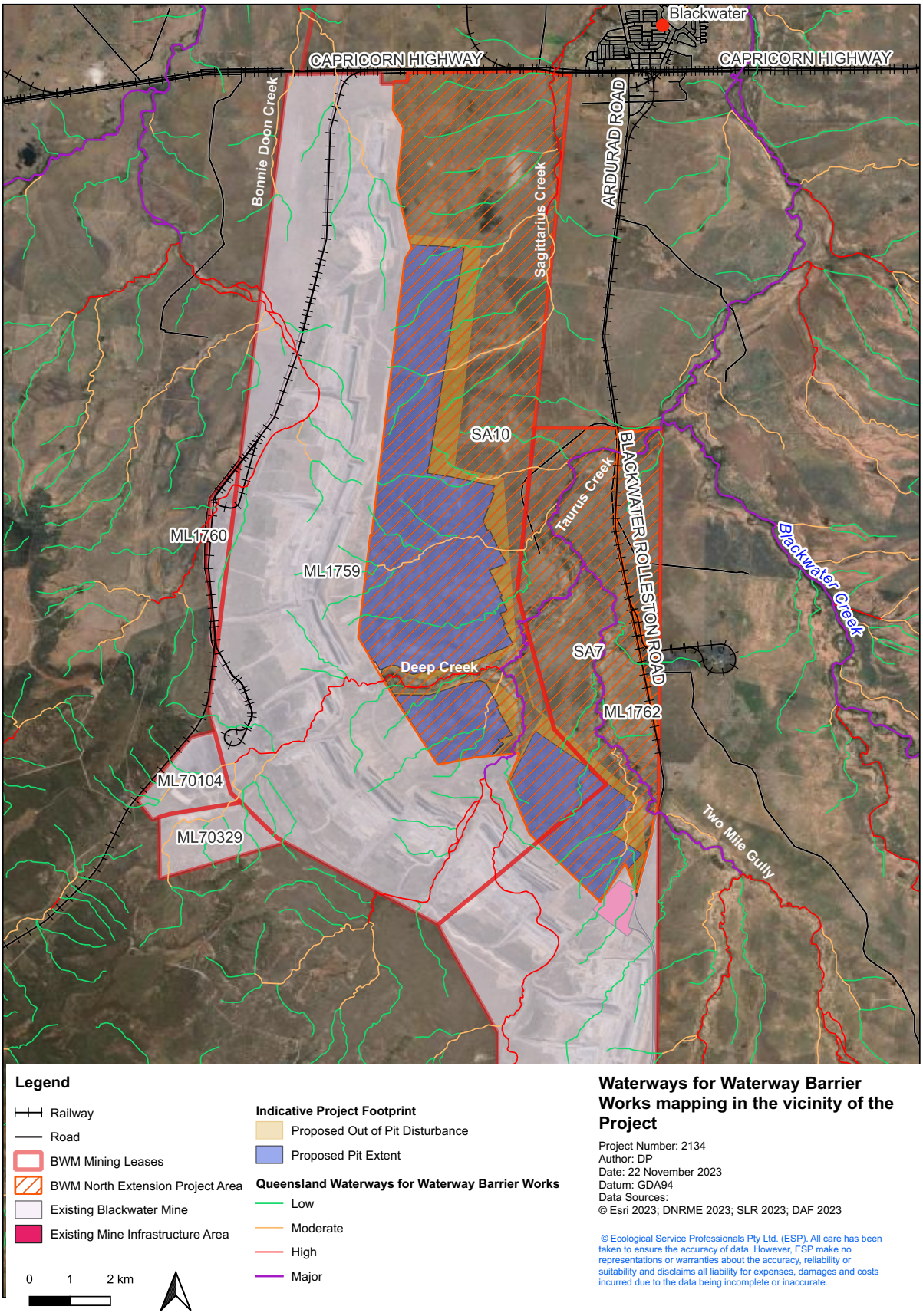

Figure 3.2 Waterway Barrier Works mapping in the vicinity of the Project

3.8.2 Listed Species

3.8.2.1 Turtles

Two species of turtle listed as potentially occurring within both the 20 km and 50 km search radius from the Project area (DCCEEW 2023a) are threatened under the NC Act: Fitzroy River turtle (listed as vulnerable) and white-throated snapping turtle (*Elseya albagula*; listed as endangered).

The Fitzroy River turtle is endemic to the natural, permanent riverine habitats in the middle to lower areas of the Fitzroy River basin in Queensland (Limpus et al 2011, DCCEEW 2023b), and has an estimated occurrence in a range of less than 10,000 km^2 (Cogger et al 1993). This species prefers permanent freshwater riverine reaches (particularly deep pools interspersed with areas of riffle habitat) and large, isolated permanent waterholes (Cogger 2000). Preferred areas have high water clarity, and are often associated with ribbonweed (*Vallisneria* sp.) beds (Cogger et al 1993, DCCEEW 2023b). Their distribution extends from the Fitzroy Barrage to the upper areas of the Dawson, Nogoa and Connors rivers. Known sites include Boolburra, Gainsford, Glenroy Crossing, Theodore, Baralaba, the Mackenzie River, the Connors River, Duaringa, Marlborough Creek and Gogango (Cogger et al 1993). Known key sites for the Fitzroy River turtle include Glenroy and Redbank crossings on the Fitzroy River, Theodore Weir on the Dawson River, Cardowan pump pool on the Connors River and Marlborough Creek (Limpus et al 2011). It has also been recorded from the following impoundments (ALA 2023):

- the Nogoa River in the vicinity of 'Duckponds' upstream of the confluence of the Mackenzie River and Comet River;
- Bedford weir on the Mackenzie River upstream of the confluence with Roper Creek; and
- Tartarus weir, on the Mackenzie River.

The white-throated snapping turtle is endemic to New Guinea and south-eastern Queensland, where it occurs in the Fitzroy River, Mary River, Burnett River, and Baffle Creek basins and associated smaller drainages in south eastern Queensland (Limpus et al 2011, DCCEEW 2023b, ABC 2023). This species prefers clear, flowing and well oxygenated rivers with sandy-gravel substrate that have suitable shelters and refuges (e.g. submerged rock crevices, undercut banks and/or submerged logs and fallen tree (Limpus et al 2011)). During the day, turtles are affiliated with habitats of high shade (i.e. submerged logs, overhanging riparian vegetation), and at night they inhabit shallow riffles. White-throated snapping turtles are well-adapted for maintaining their position at specific foraging sites in very structured habitats such as log tangles and rocky outcrops with or without currents (Limpus et al 2011). The white-throated snapping turtle has a wider distribution throughout the Fitzroy basin than the Fitzroy River turtle, occurring more widely in permanent freshwater habitat, including the upper-most spring-fed pools of the Mackenzie and Dawson sub-basins (Limpus et al 2011). It may also commonly occur in impoundments, having previously been recorded in (ALA 2023, Limpus et al 2011):

- Emerald town weir on the Nogoa River upstream of the confluence of the Mackenzie River and Comet River;

- the Nogoa River in the vicinity of 'Duckponds' upstream of the confluence of the Mackenzie River and Comet River;
- Bedford weir on the Mackenzie River upstream of the confluence with Roper Creek; and
- Tartarus weir, on the Mackenzie River.

The Mackenzie River, approximately 30 km downstream of the Project, provides habitat for both the Fitzroy River turtle and the white-throated snapping turtle. However, these species and / or suitable habitat (such as permanent riverine flowing and pool habitat) were not recorded from waterways in the vicinity of the Project during baseline field surveys (EMM 2023a), and there are no records of either species in the vicinity of the Project (ALA 2023, Limpus et al 2011). Therefore, based on desktop review of known distribution, habitat preferences, and field assessments by EMM (2023a), these turtles are unlikely to occur within or in the vicinity of the Project area, and no core foraging or nesting habitat for these species exists.

3.8.2.2 Platypus

Platypus are known to occur in the Mackenzie sub-basin and are listed as protected as 'Special Least Concern' under the NC Act.

Platypus occur in eastern Australia from Cooktown in north Queensland to Victoria and Tasmania. Platypus inhabit freshwater streams, rivers, lakes and dams. Platypus are typically nocturnal, feeding on aquatic invertebrates along the stream bed from dusk until dawn (Carrick et al 2008). When not active, platypus rest in burrows in the river bank that typically open at the water's edge amongst tree roots and overhanging vegetation. Platypus can tolerate a relatively wide range of environmental conditions, but prefer habitat that has an abundance of invertebrate prey, permanent pools and runs, moderate to good water quality, and steep well-vegetated banks for burrows. In Queensland, platypus are usually found in rivers east of the Great Dividing Range, but do occur in some western-flowing streams (ALA 2023).

There are no records of platypus from within 20 km of the Project (ALA 2023, DES 2023a), with the nearest record from the Dawson Range State Forest, approximately 30 km east of the Project area (ALA 2023). There was no platypus or potential platypus habitat recorded during the baseline field surveys for the Project (EMM 2023a). Therefore, platypus are considered highly unlikely to occur within and in the vicinity of the Project.

3.9 Matters of National Environmental Significance

Two potential controlling provisions relevant to aquatic ecology have been identified for the Project under the EPBC Act and are discussed in more detail in the subsections below, specifically:

- listed threatened species; and
- a water resource, in relation to coal seam has and large coal mining.

No other MNES relating to aquatic ecology occur or are likely to occur within the vicinity of the Project (EMM 2023a).

3.9.1 Listed Threatened Species

3.9.1.1 Fish

Two species of fish listed as potentially occurring in the vicinity of the Project are threatened under the EPBC Act: silver perch (listed as critically endangered) and Murray cod (listed as vulnerable). These species or their habitat were not identified during baseline field surveys within the Project area (EMM 2023a).

The natural distribution of the silver perch is limited to the Murray-Darling basin and their preferred habitat is high flowing rivers (DoE 2013; DCCEEW 2023b), although it has been frequently translocated across Queensland (Pusey et al 2004). This species inhabits freshwater rivers, lakes and reservoirs, typically in areas of high water flow (DoE 2013). Silver perch are a popular angling species and are also raised in aquaculture and in farm dams (Bray and Thompson 2019). They can migrate over large distances, moving between rivers and their tributaries. They are omnivorous and their diet includes larvae, molluscs, annelids and algae.

Silver perch was not listed in the EPBC Act Protected Matters Search Tool Report or the Wildlife Online database as occurring within 20 km or 50 km search radius of the Project area (DCCEEW 2023a, DES 2023a). The closest known record of silver perch is from Lake Maraboon in the Nogoa River sub-basin, approximately 75 km west of the Project, where they are stocked (State of Queensland 2020). Within the Mackenzie River sub-basin, this species was recorded in Lake Bundoora approximately 80 km northwest of the Project in 1990, though no known stocking events have occurred in the lake in the last 10 years (State of Queensland 2020). There are no known records of this species occurring in the vicinity of the Project (DES 2023a, EMM 2023a, ALA 2023). The Project area does not provide the preferred habitat of this species (i.e. flowing riverine habitat) and they are considered highly unlikely to occur in the vicinity of the Project.

The natural distribution of Murray cod is within the Murray-Darling basin only. This species was translocated to the Fitzroy River basin, and although the translocation is thought to have failed to establish a permanent population, the species is stocked throughout the basin (Pusey et al 2004, NMCRT 2010, Ye et al 2014, DCCEEW 2023b). Murray cod are frequently found in main channels of rivers and larger tributaries and are considered main-channel specialists, preferring deep pools and channels with structurally complex features such as large rocks, snags, overhanging banks and vegetation, and woody debris (DCCEEW 2023b). They are considered apex predators, actively hunting throughout the water column, and aggressively attack other fish within their territories.

Murray cod was not listed in the EPBC Protected Matters Search Tool Report (DCCEEW 2023a) as potentially occurring within 50 km of the Project, and there are no records of this species from the Mackenzie sub-basin (DES 2013a; DES 2023a; ALA 2023, DCCEEW 2023a). The closest known record of Murray cod is from Lake Maraboon in the Nogoa River sub-basin, approximately 75 km west of the Project, where they have historically been stocked (although not since the early 1990s; State of Queensland 2020). It is highly unlikely that this species would inhabit the waterways within or in the vicinity of the Project area given their ephemeral nature (i.e. lack of deep channel / pool habitat) and distance from their known range.

3.9.1.2 Turtles

Two species of turtle listed as potentially occurring within 20 km and 50 km of the Project area are threatened under the EPBC Act: Fitzroy River turtle (listed as vulnerable) and white-throated snapping turtle (listed as critically endangered). These species are considered unlikely to occur within the or in the vicinity of the Project area, as discussed above in **Section 3.8.2.1**.

3.9.2 Water Resources

Water resources within or in the vicinity of the Project area include:

- waterways (which were generally ephemeral in nature; see **Section 3.1.1**);
- lacustrine wetlands and farm dams (all if which were modified by the presence of dams; see **Section 3.1.2**);
- palustrine wetlands (see **Section 3.1.3**);
- mapped potential aquatic (i.e. surface expression) GDEs (see **Section 3.7.1**);
- subterranean GDEs, for example aquifers that may support stygofauna (see **Section 4**);
- groundwater resources (assessed in SLR 2023b and SLR 2023c); and
- terrestrial groundwater dependent ecosystems (assessed in EMM, 2023c).

3.10 Summary of Aquatic Ecosystem Values

Overall, aquatic ecosystem values of waterways within and in the vicinity of the Project area were low to moderate. Aquatic ecosystem values of waterway and wetlands are summarised in the sections below.

3.10.1 Waterways

Upper tributaries (stream orders 1 and 2) were rated as low aquatic ecosystem value due to:

- low habitat diversity and poor bio-assessment score;
- low biodiversity of aquatic flora and fauna (ephemeral waterways that are dry for much of the year);
- common species, communities, processes, and habitat types;
- no priority flora, protected aquatic species or their habitat present;
- limited potential to provide connectivity or fauna passage to upstream habitats, except during brief periods of high rainfall and flow;
- absence of dry season refugia for aquatic flora and fauna, with no water present at sites surveyed in the dry season; and
- moderate disturbance from surrounding farming and mining, although good riparian vegetation in some areas.

Riverine waterways of Sagittarius Creek, Taurus Creek and Two Mile Gully (stream order 3 and 4) were assessed as moderate aquatic ecosystem value due to:

- ephemeral waterways with poor to fair aquatic habitat;
- low cover to no priority flora;
- no protected aquatic species or habitat present;
- common aquatic flora and fauna typical of ephemeral systems in the region;
- habitat availability generally limited to periods following rainfall, although a burst pipe created dry season refuge for one site (site R4) during the baseline assessment;
- provision of connectivity and fauna passage to upstream and downstream habitats during periods of high rainfall and flow (moderate to major mapped waterways for waterway barrier works); and
- limited provision of dry season refugia for aquatic flora and fauna (outside the farm dams and wetlands assessed below).

Aquatic ecosystem value of farm dams and wetlands in the vicinity of the Project were assessed as moderate aquatic ecosystem value due to:

- modified (dammed) or ephemeral wetlands, with poor to fair aquatic habitat;
- a moderate variety of instream habitat types which provided habitat for a range of aquatic flora and fauna common in the region;
- no priority flora, protected aquatic species or habitat present;
- likely provision of breeding habitat during the wet season;
- provision of connectivity and fauna passage to upstream and downstream habitats during periods of high rainfall and flow (moderate to major mapped waterway barrier), where located on stream, although connectivity limited for off stream dams and wetland; and
- provision of dry season refugia for aquatic flora and fauna.

4 Stygofauna Communities

4.1 Stygofauna Overview

Stygofauna are subterranean aquatic fauna that live part of or all of their lives in groundwater systems (DES 2018). Stygofauna are thought to play key roles in nutrient and organic matter cycling (Danielopol et al 2003), water filtration (Asmyhr et al 2014), and modification of water flow through changes to interstitial pore spaces and mineral formation (Murray et al 2006). Stygofauna are key contributors to Australia's biodiversity (Humphreys 2006), and can act as indicators of groundwater ecosystem health (Tomlinson et al 2007).

Habitats for stygofauna include underground aquifers and caves, where they occur in water filled pore spaces and voids. Depending on where they occur, stygofauna are also referred to as (Glanville et al 2016, Tomlinson 2011):

- stygophilic fauna, which inhabit surface water and groundwater environments;
- stygoxenic fauna, which inhabit mostly surface environments, and only inhabit groundwater inadvertently and are unable to establish subterranean populations; and
- stygobitic fauna, which live exclusively in groundwater throughout their entire lifecycle.

The lithologies where stygofauna taxa are generally found include basalt, coal, gravel, sands and sandstones (DES 2018, Glanville et al 2016), but most are found in karst and alluvium (Eco Logical Australia 2014). These lithologies are typically restricted in their distribution (Glanville et al 2016) and remain unchanged over long time periods (Humphreys 2006). These factors contribute to the high degree of endemism and narrow distribution of stygofauna (Humphreys 2006).

Stygofauna communities in Australia are dominated by crustaceans, however insects, molluscs, rotifers and fish have also been recorded (4T 2012, DES 2018, Glanville et al 2016, Hose 2015). The majority of stygofauna species identified in Australia are not found anywhere else in the world (Humphreys 2006). Common adaptations of stygofauna to the absence of light and restricted space are:

- small body size (<1 mm total body length);
- lack of pigmentation;
- absence of eyes; and
- elongated appendages for tactile sensing.

In Australia, most studies on the composition of stygofauna communities and description of taxa to date have been in the Pilbara (where a highly diverse and regionally endemic community exists), New South Wales and Tasmania. In Queensland, comparatively fewer studies have been undertaken, with the majority of studies conducted in the Surat, Bowen, Fitzroy and Galilee basins in the context of Environmental Impact Studies (Hose et al 2015, Glanville et al 2016). Subsequently, knowledge of the biodiversity and value of stygofauna communities is relatively poor but is expected to increase as more studies are conducted and taxonomic knowledge improves.

4.2 Habitat Preferences and Ecology

Stygofauna are tolerant of a relatively wide range of environmental conditions and can occur in a variety of aquifer types, however they require favourable conditions to survive and not all aquifers are suitable (Doody et al 2019). Important habitat characteristics known to influence the presence of stygofauna include:

- aquifer type;
- hydraulic conductivity;
- groundwater quality;
- food supply;
- water extraction and use; and
- depth to groundwater.

Stygofauna are most commonly found in karstic and alluvial aquifers, which have high porosity (Eco Logical Australia 2014). These large pores and fractures facilitate water movement and connectivity, which is important in supplying dissolved oxygen and nutrients (Strayer 1994, Hahn & Fuchs 2009, Hose et al 2015). Although stygofauna have also been recorded from fractured rock aquifers (such as sandstone, coal and basalt), these will often only contain stygofauna when there is sufficient hydrological connection to either limestone or alluvial aquifers (Doody et al 2019). The diet of stygofauna generally consists of organic matter from seepage of surface water and biofilms comprised of microbial and bacterial microorganisms.

While a higher diversity and abundance of stygofauna is typically found near the water table (when the water table is shallower than 20 to 30 m), stygofauna can occur across a range of depths (Datry et al 2005) including, though rarely, at depths beyond 100 m below ground level (Hose et al 2015). Stygofauna are also more likely to occur in aquifer recharge areas where the water table is close to the land surface (<10 m) and near deep-rooted trees (Hancock and Boulton 2008). This is because these areas generally have higher concentrations of organic matter and dissolved oxygen (Hyde et al 2018). Diversity and abundance of stygofauna communities typically decline with depth (Datry et al 2005).

Water quality can be an important determinant in the presence and abundance of stygofauna. Stygofauna are typically most likely to occur where electrical conductivity is less than 5,000 µS/cm. Although stygofauna have been collected from aquifers with electrical conductivity of up to 56,000 µS/cm, the diversity and abundance of stygofauna typically decreases with increasing electrical conductivity above 5,000 µS/cm (Hancock & Boulton 2008, Watts & Humphreys 2009, Schulz et al 2013, Glanville et al 2016). Stygofauna can also tolerate a pH range of 3.5 to 10.3, but a higher diversity is likely to occur in aquifers with a pH range of 6.5 to 7.5 (4T 2012; Glanville et al 2016). Stygofauna are also usually found in water temperatures between 18 and 27 °C (Glanville et al 2016).

4.3 Stygofauna in Queensland

The Queensland Subterranean Aquatic Fauna Database has recorded 97 taxa of stygofauna across Queensland, including stygophilic, stygoxenic and stygobitic taxa (DES 2023c).

However, this is likely an underestimate given the limited data available, and is expected to increase as more studies are conducted and taxonomic knowledge improves.

Most stygofauna in Queensland have been found in alluvial, coal, sandstone, and volcanic deposits, with the physico-chemical conditions outlined in **Section 4.2**. The most widespread taxa of stygofauna in Queensland are syncarid isopods, which are comprised of two families (Bathynellidae and Parabathynellidae) and have been found in approximately 60% of the sampled regions (Glanville et al 2016). Other common taxa include copepod microcrustaceans (family Cyclopidae).

In comparison with other regions of Australia (i.e. the Pilbara, where most other studies have been conducted), Queensland stygofauna has a higher proportion of oligochaete worms and isopods, but fewer ostracods and copepods (Glanville et al 2016). The overall systematic composition of Queensland stygofauna is more similar to the known global average than the community composition in Western Australia, which is particularly unique (Glanville et al 2016, Halse and Pearson 2014).

4.4 Hydrogeology in the Vicinity of the Project

The litho-stratigraphy of the Project and wider surrounds is discussed in detail in the Groundwater Modelling Technical Report and Groundwater Impact Assessment (SLR 2023b; SLR 2023c). Several local hydrostratigraphic units occur, as described SLR 2023c from the shallowest (alluvium) to deepest (Burngrove Formation):

- Alluvium – Alluvial deposits are associated with local creeks. In recent years, the alluvium local to the Project area has been dry and is not considered a widely used water resource. Saturated areas are only found in few locations, where the alluvium may facilitate recharge to underlying geological units.
- Regolith – Unconsolidated surface layer of weathered rock which may provide a preferential flow pathway for groundwater, if levels exceed the base of weathering.
- Clematis Group - outcrops to the east of the Project, where it forms an elevated plateau. The unit is comprised of weathering resistant medium to coarse grained quartzose to sublabile and micaceous sandstone, siltstone, mudstone and conglomerate.
- Rewan Group - A regional scale aquitard comprising mudstones interbedded with siltstone and fine to medium grained labile sandstone. However, permeability testing indicates hydraulic conductivity values may be higher in the upper weathered zone of the unit.
- Rangal Coal Measures - Groundwater flow is primarily within the coal seams (via interconnected cleats and fractures), which are confined by low permeability overburden and interburden that essentially form aquitards. The coal measures are highly faulted resulting in compartmentalisation with coal seams juxtaposed against lower permeability interburden. Recharge to this unit occurs via direct infiltration where the unit outcrops or sub-crops.
- Burngrove Formation - Outcrops to the west of BWM and dips east below the Rangal Coal Measures. It is largely regarded an aquitard comprising interbedded siltstone, carbonaceous and tuffaceous shales, mudstone, and thin coal seams. However,

several landholder bores are apparently screened within this formation locally (assuming the registered bore database aquifer attribution is correct) suggesting it includes permeable horizons that can support low yields. This formation is considered the basement for the purposes of the SLR (2023c) assessment.

Groundwater interaction with ephemeral creeks is unlikely, with alluvium limited, both horizontally and vertically, indicating dry conditions in the alluvium and water tables well below creek beds (SLR 2023c). The Regolith is also unlikely to contain significant groundwater, and where saturated, water levels are several meters below the base of the creek bed (SLR 2023c).

4.5 Groundwater Quality in the Vicinity of the Project

In situ groundwater quality monitoring results from the two sampling events in December 2020 and May 2021 (Freshwater Ecology 2021) found that two of the eight bores sampled had groundwater quality was suitable for the presence of stygofauna (i.e. relatively low electrical conductivity <5,500 µS/cm, pH between 7 and 8 units, low turbidity <10 NTU and a dissolved oxygen percent saturation between 19 and 27%). The remaining bores had high electrical conductivity, with some also recording high turbidity and high pH (Freshwater Ecology 2021).

In the wider area, groundwater quality is typically characterised by (SLR 2023c):

- slightly acidic to neutral waters (median pH values of the formations between 6.2 and 7.2 units);
- high electrical conductivity (median electrical conductivity of the formations between 7,280 and 33,864 µS/cm) that is typically outside the preferred range for stygofauna (i.e. <5,000 µS/cm; Hancock & Boulton 2008), and
- concentrations of metals and metalloids that are typically below relevant guideline values.

There are no recent water quality monitoring results available from bores located in the alluvium in the Project area (where stygofauna are most likely to occur), due to limited groundwater presence in this unit (SLR 2023c).

4.6 Stygofauna Communities in the Vicinity of the Project

There are no known records of stygofauna (stygobitic or stygophilic fauna) in the vicinity of the Project, and they were not recorded during the pilot study for the Project from eight bores sampled across two sampling events in December 2020 and May 2021 (DES 2023c, Freshwater Ecology 2021, frc environmental 2020, State of Queensland 2014, State of Queensland 2012). No listed species of stygofauna under the EPBC Act are expected to occur within the Project area or in the vicinity of the Project.

Stygoxenes (i.e. not obligate inhabitants of groundwater systems) were recorded from six of the ten bores sampled during the pilot study, including termites (Isoptera), one soil mite (Oribatida), thrips (Thysanoptera) and springtails (Collembola) (Freshwater Ecology 2021). Stygoxenes have also been recorded in the region from the:

- Ensham Life of Mine Extension Project, approximately 35 km northwest of the Project area, where oligochaete worms were recorded from two of the 15 bores sampled (frc environmental 2020)
- Minyango Project, immediately to the northeast of the Project area, where microcrustaceans (Cyclopoida), one oligochaete worm (Naididae) and one beetle (*Hydraena* sp.) were recorded from two of the 11 bores sampled (State of Queensland 2014), and
- eastern boundary of the Project area in the Queensland Subterranean Aquatic Fauna Database, where beetles (*Hydraena* sp.) have been recorded from one bore (DES 2023b).

Overall, aquifers within the Project area are considered to have a low likelihood of supporting stygofauna communities due to the limited saturation, connectivity, depth, and suitability of groundwater quality (electrical conductivity levels outside the preferred range for stygofauna) (see **Sections 4.4** and **4.5**). Habitat is limited in the vicinity of the Project, particularly given the alluvium is typically dry (SLR 2023c). No potential subterranean GDE areas are mapped within 10 km of the Project area (Queensland Government 2023). Further, the:

- Alluvium is compartmentalised in the Project area, with limited saturated areas and limited connectivity (SLR 2023c); as such groundwater available for stygofauna communities in alluvium is likely to be limited and spatially sporadic. One bore in the Project area was attempted to be sampled during the stygofauna pilot study, but it was dry (Freshwater Ecology 2021). Limited water quality data is available because the alluvium is typically dry (SLR 2023c).
- Tertiary sediments are expected to be mostly dry in the vicinity of the Project (i.e. in the northern area discussed in SLR 2023c). Groundwater quality in the tertiary sediments south of the Project area (near Sirius Creek) is typically saline, with a median electrical conductivity of 7,280 µS/cm (SLR 2023c), which is above the preferred range for stygofauna (<5,000 µS/cm). Electrical conductivity is (spatially and temporally) variable with a range of 303 to 18,932 µS/cm (SLR 2023c).
- Triassic Clematis group has an aquifer forming unit, but there are no registered bores within this unit as they occur in elevated rugged areas (outside the Project area). Claystones between the Rewan group directly underlie the Clematis group, forming an aquitard between the Clematis group and deeper Permian Coal Measures.
- Triassic Rewan group is a regional scale aquitard (in the area to the east of the Project), although there may be some hydraulic conductivity in upper weathered zone (within the Project area). In the vicinity of the Project area, groundwater quality is generally saline, with a median electrical conductivity of 33,864 µS/cm (SLR 2023c), which is outside the range preferred by stygofauna. Electrical conductivity is (generally spatially) variable with a range of 4,253 to 37,915 µS/cm (SLR 2023c). One of the bores in weathered Rewan attempted to be sampled during the stygofauna pilot study was dry (Freshwater Ecology 2021). Three other bores were sampled, two of which had an electrical conductivity >34,000 µS/cm. One had water quality conditions only potentially suitable to support stygofauna (electrical conductivity 4,360 to 5,015 µS/cm and pH 7.2 to 7.4), and no true stygofauna were caught in the seasonal surveys.

- Permian Rangal Coal Measures have a groundwater flow that is primarily within the coal seams (via interconnected cleats and fractures) and the coal measures are highly faulted resulting in compartmentalisation. This unit is confined, and as such unlikely to be accessible to stygofauna and unlikely to have the connectivity to sources of oxygen and organic carbon (i.e. organic carbon, nutrients and oxygen in aquifers is sourced externally and enters the aquifers through recharge waters passing through shallow geological units, where there is no connection they are not replenished and habitat condition declines). To the east of the Project, it is likely too deep for stygofauna (>150 m below ground level). There may be accessible groundwater in outcrops within the Project area. However, the groundwater quality is typically saline, with a median electrical conductivity of 13,188 µS/cm and a range between 1,203 and 40,000 µS/cm (SLR 2023c), which is typically outside the range preferred by stygofauna. Five bores in the Aries coal seam were sampled in the stygofauna pilot study, three of which had electrical conductivity that were outside the preferred range for stygofauna (range from 12,206 to 21,201 µS/cm). One had water quality conditions only potentially suitable to support stygofauna (electrical conductivity 5,420 to 5,790 µS/cm and pH 7.5 to 7.9), but no true stygofauna were caught in the seasonal surveys. No water quality sample was collected from the last bore and no true stygofauna were caught in the seasonal surveys.
- Burngrove Formation is largely regarded an aquitard, although it includes permeable horizons that can support low yields of groundwater. Within the Project area and to the east of the Project, this unit is confined and deep (>100 m below ground level) and not suitable for stygofauna. Groundwater quality in the Project area is also saline, with a median electrical conductivity of 11,045 µS/cm and ranging from 5,390 to 19,317 µS/cm (SLR 2023c). To the west of the Project, it is possible that the Burngrove Formation is unconfined and may support low yields of groundwater in outcrops. Groundwater bores in this area indicates electrical conductivity is variable, ranging from 1,613 to 7,719 µS/cm (SLR 2023c).

5 Impact Assessment and Proposed Mitigation Measures

5.1 Aquatic Habitat Modification and Loss

The extent of the proposed Project open cut mining area and out of pit disturbance areas is approximately 3,761 ha. Based on the Project footprint (excluding the waterway crossings discussed in **Section 5.2**), the Project would remove or modify the following aquatic habitat (**Figure 5.1**):

- 9.3 km of mapped stream order 1 and 1.0 km of mapped stream order 2 waterways of Sagittarius Creek and tributaries;
- 4.7 km of mapped stream order 1 and 1.2 km of mapped stream order 2 waterways tributaries of Deep Creek;
- 12.6 km of mapped stream order 1 and 4.4 km of mapped stream order 2 waterway tributaries of Taurus Creek;
- 2.9 km of mapped stream order 1 and 0.7 km of mapped stream order 2 waterway tributaries of Two Mile Gully; and
- lacustrine wetlands (farm dams) mapped by BMA (**Figure 5.1**) and / or the State (refer to **Figure 1.2**), which shows there are 22 farm dams that have a total area of 10 ha.

Waterways within the Project footprint are located high in the catchment at the headwaters and are stream order 1 and 2. These waterways are ephemeral, remaining dry for prolonged periods (EMM 2023a; SLR 2023a), and as such, they do not provide aquatic habitat for the majority of the year. Aquatic flora and fauna in these upper reaches, including riparian vegetation, were limited during the baseline assessment for the Project (EMM 2023a) and aquatic ecological value was low. The two (artificial) farm dams and a flood channel wetland surveyed during the baseline assessment for the Project (EMM 2023a, sites L1, L2 and RW1 on **Figure 2.1**) were of moderate aquatic ecological value as they provided a dry season refuge and connectivity to upstream and downstream habitats during periods of high rainfall and flow; these dams and wetlands are not located within the open cut mining area and out of pit disturbance areas, and will therefore not be directly disturbed (although as outlined above several lacustrine wetlands in the form of farm dams within the Project footprint will be removed).

Waterways within the Project footprint are yet to be mapped under the Water Act, however, it is considered that these would be classified as drainage features (SLR, 2023a) (refer to **Section 1.3.1**). All aquatic habitat and species within this area were considered common to the region, with no aquatic species listed under the EPBC Act or NC Act detected or considered likely to occur in this area (EMM 2023a). While their removal will mean a direct loss of available aquatic habitat, this is not expected to impact aquatic ecology on a regional scale, but rather on a localised scale within the Project footprint.

Removal of waterways and wetlands in the upper catchment also has the potential to reduce or limit aquatic habitat available to fauna (e.g. woody debris, tree roots or undercut banks) in downstream areas (as the source of habitat material is removed), indirectly impacting aquatic fauna. However, while these aquatic habitats (e.g. woody debris and detritus) occur in some

areas in the Project area (EMM 2023a), they are generally limited and would likely result in minor impacts to downstream waterways.

Key mitigation and management measures for the removal or modification of habitat include:

- Avoiding disturbance to major waterways (stream order 3 and above) of Deep Creek, Sagittarius Creek, Two Mile Gully and Taurus Creek; the Project will also avoid disturbance to riparian areas.
- Salvage and translocate large native aquatic fauna (e.g. fish and turtles) from wetlands (i.e. farms dams) prior to removal, where possible.
- Limiting the area disturbed at any one time by careful mine stage planning, which minimises the area of the overall disturbed landform (notably the area of the operating pits).
- Progressive and timely re-instatement and rehabilitation of the disturbed landform consistent with the rehabilitation criteria in the BWM EA.

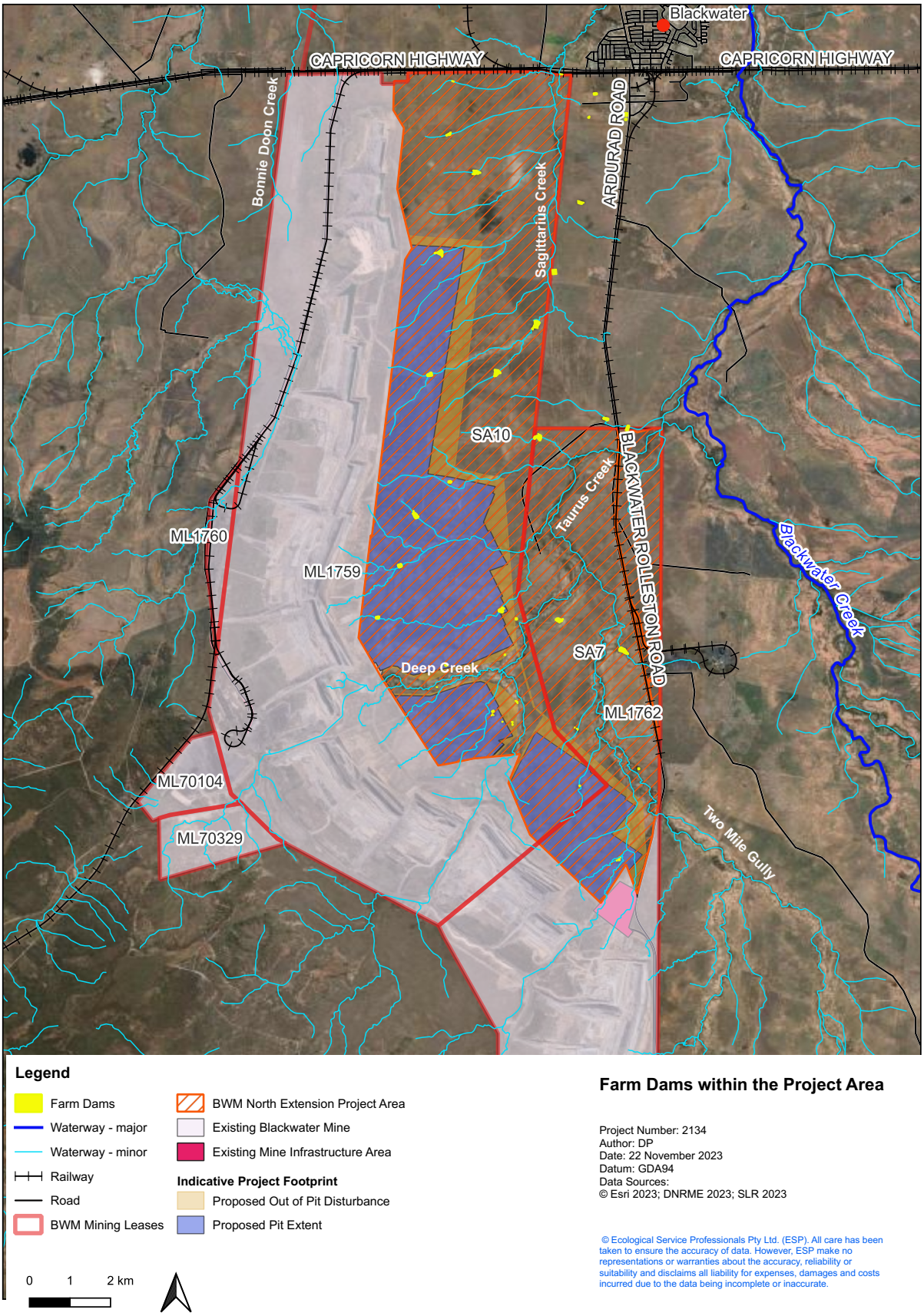

Figure 5.1 Waterways mapped by the State and farm dams (lacustrine wetlands) mapped by BMA within the Project footprint

5.2 Fish Passage

Native fish and other fauna require some physical instream habitat for shelter and/or reproduction, and many also require connectivity of waterways for migrate upstream and downstream at different stages of their life cycle. The removal of sections of waterways and the installation of waterway crossings have the potential to prevent or restrict the movement of aquatic fauna, such as fish.

During the aquatic ecology baseline surveys, nine species of native fish were recorded at riverine and floodplain sites on Taurus Creek (sites R4 and RW1) and a farm dam site on Sagittarius Creek (site L1) (EMM 2023a; refer to **Section 3.6.1**). All species were considered common to the Mackenzie River sub-basin, with no aquatic species listed under the EPBC Act or NC Act detected or considered as potentially occurring in this area (EMM 2023a). Fish communities were dominated by small-bodied species, with the lack of large-bodied fish likely due to the paucity of deep pool habitats within the waterways sampled.

The Project will result in the removal of some tributaries of Deep Creek, Sagittarius Creek, Two Mile Gully, and Taurus Creek, as well as a section of Sagittarius Creek within the Project footprint (as discussed in **Section 5.1** and shown on **Figure 5.1**). The level of 'risk' associated with undertaking waterway barrier works within the Project footprint includes a total of (refer to **Section 3.8.1; Figure 3.2**):

- 9.3 km of mapped low (green) and 1.0 km of mapped moderate (amber) waterways of Sagittarius Creek and tributaries;
- 4.7 km of mapped low (green) and 1.2 km of mapped moderate (amber) waterways of Deep Creek tributaries;
- 12.6 km of mapped low (green) and 4.4 km of mapped moderate (amber) waterways of Taurus Creek tributaries; and
- 2.9 km of mapped low (green) and 0.7 km of mapped moderate (amber) waterways of Two Mile Gully tributaries.

Waterways within this area provide low aquatic ecological value and are low stream-order. These waterways are ephemeral, and as such fish habitat and passage is restricted to periods during and immediately following rainfall. During these times, there are several moderate ecological value farm dams in the Project footprint (total area 10 ha, refer to **Section 5.1**) that they provide connectivity to, with the level of connectivity varying for each e.g. on stream and off stream waterbodies (**Figure 5.1**). However, these waterways do not connect to important fish habitat upstream, given upstream reaches are within existing active mining areas. As such, the Project would remove these waterways and farm dams providing fish habitat within the Project footprint, but would not fragment fish habitat in these waterways as they do not connect to fish habitat further upstream.

There are two waterway crossings associated with the Project (refer to **Section 3.8.1; Figure 3.2**):

- A dragline crossing (up to 50 m wide) of Deep Creek, where it is mapped a high (red) waterway barrier works risk waterway.
- An infrastructure crossing of Taurus Creek, where it is mapped a major (purple) waterway barrier works risk waterway.

The dragline crossing is designed to allow the machine to walk down into, across and out of the creek bed. The crossing will be at creek bed level and will not restrict flow. No culvert pipes will be installed, and the upstream and downstream edges of the crossings will be protected by rock. Dragline crossing events will not occur on a frequent basis and when they do, they will not be scheduled to occur during wet weather or stream flow. The dragline crossing across the waterway will not be permanent, however, the route created on the approaches to and from the creek may last several years. Upstream of the proposed dragline crossing, Deep Creek traverses active mining areas via the Deep Creek Diversion which conveys flows to the New Deep Creek Dam, which is an on-stream structure. Flows discharging from this Dam are typically via the spillway rather than pumped releases and are subject to minimum flow rates being achieved in the receiving waters and water quality limits being achieved in the release points, in accordance with the EA (SLR 2023a).

The infrastructure crossing of Taurus Creek will include a Back Access Road crossing of Taurus Creek (as well as other infrastructure such as electricity transmission lines). The Back Access Road will be designed as a low-level culvert crossing in general accordance with the Accepted Development Requirements (ADR) for high (red) risk waterway barrier works (DAF 2020) and will be consistent with the Department of Transport and Main Roads Drainage Manual (TMR 2023). The pipes that convey flow will be installed at existing creek invert levels to allow fish passage and will be stabilised by rock protection. The flood design event (1:20) for the Back Access Road is such that in large events the crossing structure is overtopped. Upstream of the proposed Back Access Road crossing, Taurus Creek and Deep Creek (which flows into Taurus Creek) traverse active mining areas via the Deep Creek and Taurus Creek diversions, and have existing limitations to fish passage further upstream, with onstream structures including the New Deep Creek Dam and New Taurus Creek Dam.

Mitigation and management measures for the removal waterways and farm dams within the Project footprint are outlined in **Section 5.1**. In addition, mitigations measures implemented to reduce the potential impact on fish passage include:

- Taurus Creek Back Access Road crossing will be designed in general accordance with the ADR for high (red) risk Operational Work that is Constructing or Raising Waterway Barrier Works (DAF 2020) and will be consistent with the Department of Transport and Main Roads Drainage Manual (TMR 2023).
- Construction of the dragline crossing will be at bed level (with no culverts) and will allow for fish passage. Construction and crossing events will not be scheduled to occur during wet weather or stream flow.
- When equipment is required to cross creeks, temporary ‘bed and banks’ disturbance permits are issued by the BWM site environment team, which outline the requirements to minimise impacts to environmental values associated with the particular creek and its surrounds.
- Key management plans will be implemented to manage waterways, including the BWM Water Management Plan and BWM Erosion and Sediment Control Plan, and impacts to downstream water quality and aquatic ecology will be monitored in accordance with the BWM EA REMP conditions.
- Progressive rehabilitation of the disturbed landform, with a final landform that will be stable and flood flows will be free draining (SLR 2023a).

5.3 Water Management Strategy

The water management strategy developed for the Project is a continuation of the existing water management strategy, with various water supply upgrades (SLR 2023a).

The existing water management strategy includes the separation and management of clean and MAW/sediment-laden water catchments (SLR 2023a):

- Where possible, stormwater runoff from undisturbed areas both on and surrounding the mine site is diverted away from disturbed areas into adjacent waterways as part of normal overland flow.
- Disturbed area runoff is captured and treated in sediment/environmental dams and used preferentially for dust suppression and coal processing to minimise the likelihood of offsite water discharges (refer to **Section 5.5** and **Section 5.6**).
- MAW is captured and treated in the BWM water management system where it is then transferred to be preferentially used for process water or dust suppression. If required, it is discharged off-site in compliance with the BWM EA EPML00717813 (refer to **Section 5.4**).

Clean water captured on site in clean water storages and released to adjacent waterways is expected to have the same water quality as the receiving environment waterways, and therefore, is not expected to pose a significant adverse impact on surface water quality in the receiving environment.

5.4 MAW Releases

MAW will continue to be sent to inactive pits for storage where it is called on to meet the various site demands as required. The current EA allows for discharge from Tannyfoil Dam, New Taurus Creek Dam and New Deep Creek Dam subject to minimum flow rates being achieved in the receiving waters (i.e. minimum flow of 1 m^3/s in the receiving waterway of Burngrove or Blackwater creeks) and water quality limits being achieved at the release points. No changes to the existing authorised surface water release points or release conditions defined in the EA are proposed (SLR 2023a). New Deep Creek and New Taurus Creek storages are on stream storages with large natural catchments and the storages are typically overflowing when the downstream release conditions are triggered. As such, the majority of water removed from the system via these storages is through the spillway rather than pumped releases. This is expected to continue following the Project, with sufficient capacity within the designated storages. The predicted annual controlled release volumes during the Project are in the order of 100 ML/year due to the site retaining water to satisfy mine water demands under moderate and dry conditions (SLR 2023a). The potential releases through controlled release and overflows are in the order of 4 GL/year in a P50 moderate climate and up to 9 GL/year in a P95 wet climate (SLR 2023a). This is due to a number of the storages being on stream storages where water is released via the spillway and comprises of a large proportion of water that is flowing through the site from upstream undisturbed catchments (SLR 2023a).

The BWM REMP has been developed and implemented to monitor and assess the potential impacts that releases of MAW and associated contaminants have on the receiving

environment. Previous REMP results generally indicate water quality is within acceptable limits for slightly to moderately disturbed systems, and sediment and the macroinvertebrate indicators do not show changes downstream of mining that would warrant investigation (Gauge Industrial & Environmental 2013; 2014; 2017; 2021; 2022; Hydrobiology 2016; 2019). Given there are no changes to the EA proposed, changes to water quality from MAW releases are expected within acceptable levels for moderately disturbed systems.

In accordance with the Environmental Protection Regulation 2019, the Project has been assessed against Great Barrier Reef discharge standards for industrial activities (SLR 2023a). Under the guideline the release of dissolved inorganic nitrogen (DIN) and fine sediment within waterways that ultimately drain to the Great Barrier Reef must be considered. Overall, DIN load from the system associated with releases is expected to be minimal (SLR 2023a).

Further details regarding potential impacts to surface water quality from MAW releases are outline in the *Surface Water Impact Assessment* (SLR 2023a) for the Project. Mitigation measures for surface water quality are outlined in the *Surface Water Impact Assessment* (SLR 2023a) and include (but are not limited to):

- The existing Mine Water Management Plan will be expanded to incorporate the operational phase of the Project.
- The current REMP or Fitzroy Regional Receiving Environment Monitoring Program (FRREMP) and associated water quality monitoring program will continue for the Project in accordance with the EA. The program is designed to ensure the water management plan is effective, to demonstrate compliance with the discharge limits in the EA, and to ensure the downstream water quality is not being adversely impacted.
- Progressive rehabilitation will be undertaken to reduce the amount of disturbed area.

Given there are no changes to the existing release points and EA conditions for releases proposed and where the mitigation, management strategies and monitoring for surface water are implemented, potential adverse impacts on surface water quality (and therefore aquatic ecology) of the receiving environment are expected to be low risk.

5.5 Surface Water Quality

Increased suspended sediment and / or sedimentation can potentially impact the health, composition and resilience of aquatic fauna and flora indirectly, by affecting respiration, breeding and feeding (e.g. clogging fish gills), or directly, by burying benthic communities. High levels of turbidity can impact growth and diversity of aquatic plants and algae as light required for photosynthesis is reduced (although aquatic plants were not highly abundant in the Project area; EMM 2023a). Increased nutrients can also lead to increased aquatic plant growth and algal blooms, potentially resulting in high dissolved oxygen concentrations during the day (during net photosynthesis), but very low dissolved oxygen concentrations during the night and early morning (during respiration). In extreme cases, this can lead to eutrophication and fish kills. Contaminants (typically metals and hydrocarbons) can influence the health, reproduction and, at high enough concentrations, can cause direct mortality of aquatic flora and fauna. The type, volume and concentration of sediments, nutrients and contaminants, along with environmental factors (e.g. dilution, mixing, existing exposure levels), determines the severity of impact.

Without adequate controls in place, potential impacts to surface water quality as a result of the Project include:

- Vegetation clearing and earthworks (e.g. topsoil stripping) may influence bank stability and erosion, which, in turn, can impact water surface quality (particularly turbidity and sedimentation) downstream waterways. Risks are greater during times of high flow (when there is a greater risk of erosion and / or stormwater runoff), and close to the disturbed area, decreasing with distance downstream.
- Surface water runoff from mine affected areas may release contaminants into downstream waterways.
- Dust from mining activities may enter waterways and increase turbidity, sedimentation, nutrients and contaminants (e.g. from mining waste) in downstream and / or adjacent waterways.
- Fuels, oils and other chemicals required for vehicles and equipment used during the Project (including chemicals for blasting) may spill and enter waterways, impacting water quality.
- Uncontrolled release of MAW, which may adversely impact on receiving water quality.

Mitigation and management measures will be implemented to minimise the potential for impacts to surface water quality, including (SLR 2023a):

- The BWM Water Management Plan and BWM Erosion and Sediment Control Plan will be reviewed and expanded, where necessary, to include the Project to manage water on site and erosion and sedimentation. Appropriate sediment control measures (e.g., sediment fences and sediment filters) will be established as required to reduce the amount of runoff from disturbed areas in accordance with the BWM Water Management Plan and BWM Erosion and Sediment Control Plan.
- Construction of any temporary waterway crossings will occur over the dry season to minimise soil disturbance on adjacent waterways.
- Areas which are not required for the ongoing operation of the Project will be rehabilitated as soon as practicable to reduce exposed soils.
- Fuel, dangerous goods and hazardous chemicals will be managed as outlined by current standards, guidelines and in compliance with statutory requirements. Refuelling facilities, bunding or storage facilities for hydrocarbons and chemicals will be in appropriately designed sites and comply with Australian Standards (e.g. AS 1940: The storage and handling of flammable and combustible liquids).
- The existing BWM spills and emergency response procedures will be implemented for the Project. Spill recovery and containment equipment will be available when working adjacent to sensitive drainage paths and within other areas, such as workshops. Fuels and chemicals will not be stored or handled within 200 m of waterbodies. Personnel will receive appropriate spill clean-up training. Vehicles and equipment will be maintained to minimise risk of spill or leakage.
- Dust management measures will continue to be implemented at the BWM and dust suppression implemented such as wetting down dirt roads. Release of dust and / or particulate matter from the mining activities at BWM will be managed under the EA and BWM Air Emissions Management Plan.

- Continued water quality monitoring in accordance with the EA REMP / FRREMP condition to ensure downstream water quality is not being adversely impacted.

Following mine closure, the BWM Progressive Rehabilitation Closure Plan (to be developed) will incorporate management measures to reduce the impacts on receiving environment water quality.

Further details regarding potential impacts to surface water quality and associated management and mitigation measures are outlined in the *Surface Water Impact Assessment* (SLR 2023a) for the Project. The risk of adverse impacts to the water quality downstream of the Project is minimal where the above management strategies for surface water management are implemented (SLR 2023a). Given this, the risk of potential impacts to aquatic ecological values of the receiving environment as a result of changes to water quality are predicted to be low.

5.6 Surface Water Run-off or Seepage from Spoil

Where mining related saline or acid mine drainage surface water run-off or seepage reaches the receiving environment, potential impacts to aquatic ecology can include (Commonwealth of Australia 2016, Dunlop et al 2005):

- contamination of water quality and sediment quality;
- poor health and possible death of fish and other aquatic organisms;
- reduction of in-stream and riparian vegetation;
- promotion of noxious plant growth;
- visual changes to waterways: waterways can become red coloured or unnaturally clear, or introduce precipitates on the surface or water or bank edges; and
- loss of EVs associated with the waterways.

The management of overburden and interburden materials (spoil) generated by the Project will be consistent with the current BWM Waste Management Strategy, where spoil is disposed into in-pit spoil dumps, then progressively rehabilitated, with run-off and seepage captured by the BWM water management system (Terrenus Earth Sciences 2022).

Spoil is overwhelmingly non-acid forming (NAF) with excess acid neutralising capacity (ANC) and has a negligible risk of developing acid and metalliferous drainage (AMD), including acid/acidic drainage (AD), neutral and metalliferous drainage (NMD) or saline drainage from sulfide oxidation (SD). Furthermore, surface water run-off and seepage from spoil is expected to be non-saline with relatively low soluble metal / metalloid concentrations. However, spoil is expected to be strongly sodic with potential for dispersion and erosion (Terrenus Earth Sciences 2022).

Further details regarding potential impacts associated with spoil are outlined in the *Geochemical Assessment of Potential Spoil, Coal Tailings and Coarse Reject Materials* (Terrenus Earth Sciences 2022). With the implementation of the spoil management and mitigation measures, spoil is regarded as posing a low risk of environmental harm (Terrenus Earth Sciences 2022). As such, adverse impacts to downstream aquatic ecology are not expected.

5.7 Flow Regime

Changes to the flood regime, and the timing and magnitude of flows in watercourses, have the potential to directly and indirectly impact on aquatic ecosystems by (Bunn and Arthington 2002, Poff and Zimmerman 2010, Rolls et al 2012):

- influencing the success of the life cycles of aquatic species that have adapted to natural flow regimes and have evolved in response to natural variation (i.e. affecting cues for movement, migration and breeding);
- changing the diversity and structure of instream physical habitats, which can influence the composition of biotic communities;
- affecting water quality through changes to the flushing of water;
- increasing scouring and erosion of watercourses influences habitat conditions and further affects water quality;
- changing the variation in connectivity along the length of rivers and between rivers and floodplains; and
- decreasing the successful invasion of exotic and pest species.

General presumptive standards have been developed to provide riverine ecosystems protection, with a less than 10% change in flows likely to achieve a high level of ecosystem protection; and 11 to 20% change in flows likely to achieve a moderate level of ecosystem protection (Richter et al 2011). While these recommendations and presumptive standards are based on perennial streams with an emphasis on baseflow, they also provide good general guidance for ephemeral waterways with no baseflows in the absence of available information on these waterways. However, there are a number of factors that are particularly important to consider for ephemeral waterways, including the duration and timing of flow and no flow events (particularly those that may trigger migration and breeding) as well as the presence of dry season refugia.

The Project does not involve any watercourse diversions or water extractions from watercourses or groundwater, and proposed works are located within the Project footprint. Changes in water flow may result from (SLR 2023a):

- Changes in the catchment area in the upper reaches of waterways.
- Release of MAW from the site, which are expected to be minimal given stream storages have large natural catchments, and releases are expected to be mainly released via the spillway overflow and in accordance with the existing EA (refer to **Section 5.3**).
- Construction of flood protection levees and / or landforms during operations, which are expected to be minimal, being confined to the immediate vicinity of the Project and influence flows during rare significant flood events (refer to **Section 5.8**).
- Changes in groundwater, which are expected to be minimal at Blackwater Creek (refer to **Section 5.11**).

The Project footprint covers an area of 3,761 ha, which equates to approximately 0.29% of the Mackenzie River sub-basin (1,305,900 ha) and 0.03% of the Fitzroy River basin (14,266,500 ha).

The Project has the potential to impact on stream flows due to loss of catchment area draining to local waterways. Catchment area to these waterways is reduced through the Project's activities as disturbed catchment areas are directed to the MAW management or ESC system for capture, treatment, and reuse. The captured catchment will change as the mine develops and has the potential to influence flows in downstream sections of Sagittarius Creek, Taurus Creek, Deep Creek and Blackwater Creek.

Table 5.1 provides information on the total catchment area for each creek and the proportion of the catchment captured by the Project (SLR, 2023a). This is based on the maximum disturbance area and is conservative in that it does not consider any treatment and release of water in accordance with the BWM EA. Based on the Project footprint (i.e. the maximum disturbance area), the change to the estimated flow exceedance at the 50th, 80th and 90th percentiles is < 10%, except for Sagittarius Creek at the ML Boundary, which is expected to decrease by 11% for the 90th percentile flow exceedance (SLR 2023a). Due to the ephemeral nature of the creeks, flows are minimal and infrequent, and as such changes in flow due to catchment loss are minimal. The potential impact on water flow in Blackwater Creek at the confluence with Taurus Creek and further downstream at the town of Blackwater is likely to be undetectable (SLR 2023a). As such, the changes in flow due to loss of catchment area are acceptable (in accordance with the general presumptive standards outlined in Richter et al 2011) for the low to moderate aquatic ecosystem value waterways downstream of the Project.

Table 5.1 Estimated changes to catchment area and flow (after SLR, 2023a)

Location	Change in Catchment Area (%)	Change in Flow (%)		
		50th Percentile Flow Exceedance	85th Percentile Flow Exceedance	90th Percentile Flow Exceedance
Sagittarius Creek at the ML Boundary	-11	None, no flow	None, no flow	-11
Deep Creek	-7	-8	-7	-7
Taurus Creek	-3	None, no flow	None, no flow	-3
Taurus and Deep Creek Confluence	-4	None, no flow	None, no flow	-4
Blackwater Creek at Blackwater Town	-2	None, no flow	None, no flow	-2
Blackwater and Sagittarius Creek Confluence	-3	None, no flow	None, no flow	-3

Overall, potential impacts to flows and surface water hydrology will be reduced by:

- Limiting the area disturbed at any one time by careful mine stage planning, which minimises the area of catchment loss.
- Progressive and timely re-instatement and rehabilitation of the disturbed landform, with a final landform will be stable and flood flows will be free draining (SLR 2023a).

- Design and construct the levee and waterway crossings to minimise impacts to water flow and surface water hydrology.

Further details regarding potential impacts to flows are outlined in the *Surface Water Impact Assessment* (SLR 2023a). Adverse impacts to aquatic ecology from changes in flow as a result of the Project are expected to be low risk.

5.8 Flood Regimes

Protecting the pits from flood ingress will require the construction of flood protection levees and / or flood protection landforms during operations (SLR 2023a). Hydrologic modelling has been used to simulate the 0.1%, 2% and 50% Annual Exceedance Probability (AEP) storm events for the existing, future (i.e. expansion of mining operations into SA7 and SA10 from the Project and including proposed flood protection levees / landforms) and end of life (i.e. following completion of mining of SA7 and SA10) scenarios. The results show (SLR 2023a):

- In the 0.1% AEP, peak flood levels in Taurus Creek downstream of SA7 and SA10 are generally reduced in the future scenario compared to the existing scenario. In Blackwater Creek, downstream of the junction with Taurus Creek, peak flood levels are approximately 70 mm lower than in the existing scenario.
- Local increases in peak flood levels occur within Deep Creek and Taurus Creek as a result of the flood protection levees / landforms. Increases in peak flood levels in Taurus Creek range from 10 mm to 500 mm, although generally less than 100 mm. Isolated increases are also shown at the junction of Deep Creek and Taurus Creek adjacent to the flood protection landform (FP2). The increases are localised and wholly contained within ML 1759 and ML 1762.
- Flow behaviour (stream power, velocities and shear stresses) resulting from the Project is expected to be unchanged from the existing conditions during the 2% and 50% AEP events.

Potential impacts to aquatic flora and fauna are likely to be restricted to changes in flood levels during rare significant flood events (i.e. when the flood protection levees / landforms influence stream levels). Further details regarding potential impacts to flood regimes are outlined in the *Surface Water Impact Assessment* (SLR 2023a). Given changes in flood regimes are restricted to localised changes in flood levels during rare significant flood events, adverse impacts on aquatic ecology are expected to be minor.

5.9 Litter and Waste

Where litter and waste associated with pre-mining activities, vehicle maintenance and mining operations enter aquatic ecosystems they have the potential to directly impact aquatic fauna due to entanglement. They can also indirectly impact aquatic flora and fauna by contributing to the degradation of water and sediment quality.

The existing BWM Waste Management Plan will be reviewed, and updated as required to manage waste produced by the Project. The BWM Waste Management Plan uses the waste management hierarchy (avoid / reduce, reuse, recycle, recover, treat and dispose) as a framework for prioritising waste management practices to achieve the best environmental

outcome. General wastes and regulated wastes are segregated in accordance with the BWM EA.

Where appropriate controls are in place, including the existing BWM Mine Waste Management Plan, Erosion and Sediment Control Plan and EA requirements, the risk to aquatic ecology from litter and spilt waste from the Project is likely to be low.

5.10 Proliferation of Aquatic Pests

Increases in invasive species can lead to significant indirect impacts to the community structure and health of aquatic ecosystems through:

- out-competing native species for resources and space;
- degrading habitat conditions as a result of feeding behaviors (fish) and growth patterns (plants);
- reducing water quality (e.g. changing dissolved oxygen levels or increasing turbidity); and
- resulting in the decline and/or displacement of species reducing the overall diversity of the community.

The Project is unlikely to result in the addition of new invasive species of aquatic flora or fauna, or the growth and spread of aquatic pest species. This is due to its location within the catchment; because it does not involve the diversion of waterways into adjacent catchments; and because it does not result in additional habitat for invasive species. Weed management (prevention, monitoring and control) will be undertaken to mitigate the abundance and species of weeds. Weed hygiene protocols will continue to be implemented using the dedicated vehicle and machinery cleaning bay located at the mine infrastructure area. Given the controls in place, risks are expected to be low.

5.11 Changes to Groundwater

5.11.1 Groundwater Drawdown

From the groundwater model, the Project is expected to result in (SLR 2023c):

- No incremental drawdown impacts for the alluvium as a result of the Project (incidental water impacts on the alluvium are described in **Section 5.11.3**).
- Maximum predicted incremental drawdowns within the weathered zone associated with the Project is largely confined to near the pit and influenced by the distribution of predicted saturated zones. Cumulative drawdown impacts (i.e. the total impact of mining by all current mining and foreseeable mining, including the Project) within the weathered zone is more widespread.
- No incremental drawdown in the Clematis Sandstone, and minimal drawdown in the Rewan group.
- Incremental drawdown in the Permian Coal Measures within the mined coal seams that is influenced by unit structure and is confined to unit extents. To the west, the extent is limited to near the pit due to the structural geology, towards the east

drawdown is the vicinity of Blackwater Creek (laterally at depth, not vertically into the shallow formations, such as alluvium or tertiary). Maximum cumulative drawdown is bounded on the western side by the coal seam outcrop and predicted to extend generally a distance of 5 to 7 km east of the mining areas. The cumulative drawdown reaches the model boundary in the northeast, which coincides with a major fault.

- Maximum predicted incremental and cumulative drawdown for the Burngrove Formation are similar to the drawdown in the Permian Coal Measures, with incremental drawdown limited to the area of outcrop and maximum cumulative drawdown extending approximately 5 to 7 km east of the mining areas.

5.11.2 Incidental Water Impacts – Influence on Alluvium

Interference of the alluvial groundwater can occur due to reduced upward leakage from Permian coal measures that are depressurised because of mining activities. Over the extent of Quaternary alluvium along Blackwater Creek, there is a maximum flow reduction of 0.23 ML/day from underlying formation to alluvium as a result of the Project. The scale of change in the alluvium is considered to be very minor (SLR, 2023c).

5.11.3 Incidental Water Impacts – Groundwater-Surface Water Interaction in Blackwater Creek

The change in groundwater flow to Blackwater Creek due to the Project was calculated to be approximately 0.01 ML/day over the life of mine. Given the Blackwater Creek is highly ephemeral, the alluvium is not contributing large amounts of water and this reduction due to the Project was considered insignificant and within the bounds of model error (SLR 2023c).

5.11.4 Groundwater Quality

Groundwater quality will continue to be managed in accordance with the EA (SLR 2023c). MAW will be managed as outlined in **Section 5.3** and seepage will be managed as outlined in **Section 5.6.** Final void areas will act as a groundwater sink, which means that groundwater will flow into the voids (SLR, 2023c).

A routine groundwater monitoring program and criteria to protect environmental values is implemented in accordance with the existing EA (which is currently being reviewed and updated in collaboration with the Administering Authority). The groundwater monitoring program will continue for the life of the Project (SLR 2023c).

Further details regarding potential impacts to groundwater are outlined in the *Groundwater Impact Assessment* (SLR 2023c).

5.11.5 Aquatic GDEs

Aquatic GDEs have the potential to be impacted by changes in groundwater quality, quantity, and interactions.

There are no surface expression (aquatic) GDEs located within the Project area (SLR 2023a). Groundwater interaction with ephemeral creeks in the Project area is unlikely, with alluvium limited, both horizontally and vertically, indicating dry conditions in the alluvium and water tables below creek beds. The alluvium in this area is compartmentalised and mainly

recharged by rainfall and associated creek flows. The Regolith is also unlikely to contain significant groundwater, and where saturated, water levels several meters below the base of the creek bed. As such, there is a low potential for waterways and wetlands associated with Sagittarius Creek, Deep Creek, Taurus Creek and Two Mile Gully to be aquatic GDEs (EMM 2023a; SLR 2023a). Further, groundwater in the alluvium associated with waterways and wetlands in this area is perched and would not be affected by drawdown from the Project.

Further downstream, Blackwater Creek is mapped as a moderate potential aquatic GDE. As described in **Section 5.11.3,** the change in groundwater flow to Blackwater Creek due to the Project was calculated to be approximately 0.01 ML/day over the life of mine and is considered insignificant (SLR, 2023c).

As described in **Section 5.7**, the Project has the potential to impact on streamflow due to loss of catchment area draining to local waterways. The potential impact on water flow in Blackwater Creek at the confluence with Taurus Creek and further downstream at the town of Blackwater is likely to be undetectable (SLR 2023a). There would be no change during dry periods and potential impacts would be less than this (<2%) during periods of high flow (Blackwater Creek at Blackwater township) (SLR 2023a).

As such, potential impacts to the aquatic ecology and moderate potential aquatic GDE of Blackwater Creek is expected to be minor.

Management of groundwater in accordance with existing mitigations and measures (i.e. as outlined in **Section 5.3**) are not expected to result in adverse impacts to groundwater quality (SLR 2023c).

5.11.6 Stygofauna

5.11.6.1 Physical Disruption of Aquifers

The physical disruption of aquifers can directly impact stygofauna communities inhabiting them. This can be due to excavation of mining pits and compaction of aquifer sediments by heavy machinery and equipment. Physical disruption of aquifers can reduce the amount of favourable subterranean aquatic habitat available for stygofauna communities. Within the Project footprint, the alluvium is typical dry and compartmentalised, Tertiary Sediments and the Rewan group are typically saline (with limited suitability for stygofauna), and the Rangal Coal Measures are confined (**Figure 5.2**; SLR 2023c). There are no known records of true stygofauna (stygobitic or stygophilic fauna) in the vicinity of the Project, and they were not recorded during the pilot study for the Project (DES 2023c, Freshwater Ecology 2021, frc environmental 2020, State of Queensland 2014, State of Queensland 2012). No listed species of stygofauna under the EPBC Act are expected to occur within the Project area.

Given the Project area provides limited suitable habitat for stygofauna and they are unlikely to occur, the risk of direct impacts to stygofauna from physical disruption of aquifers is considered to be low.

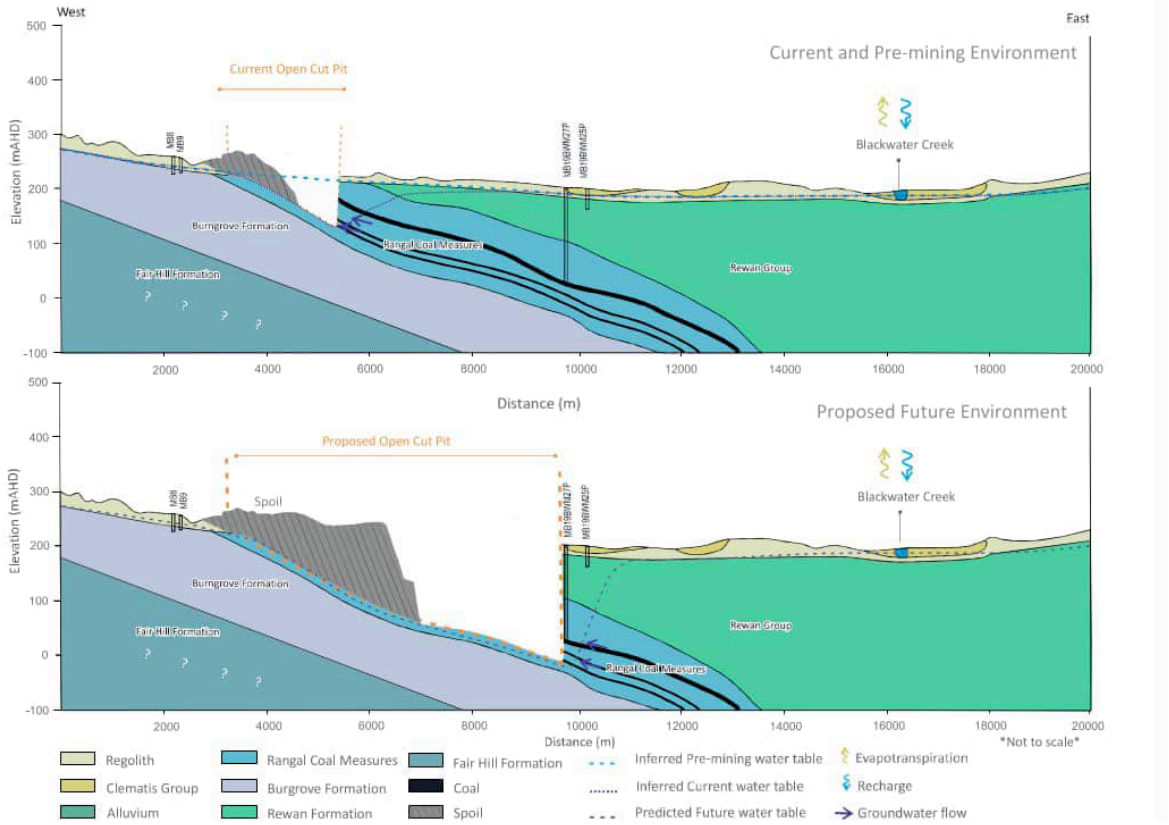

Figure 5.2 Conceptual hydrogeological section of the Project area. Source: SLR 2023c

5.11.6.2 Groundwater Quantity

Changes to groundwater quantity have the potential to directly and indirectly influence stygofauna communities. Where recharge rates are less than extraction rates, stygofauna communities can be directly affected, particularly as they prefer shallow aquifer systems. A reduction in hydraulic pressure (e.g. from depressurising coal seams) can also potentially result in induced flow from overlying aquifers, potentially resulting in decreased available groundwater resources and indirectly impacting stygofauna communities. Stygofauna can often cope with small and slow declines in aquifer storage levels, but rapid declines can have detrimental impacts. The extent to which they are impacted depends on the timing, frequency, duration, extent and depth of water extraction (Car 2010).

The is no incremental drawdown predicted for the alluvium as a result of the Project (SLR 2023c). There is very minor incremental drawdown expected in the Rewan group given this is a regional aquitard (outside mined areas; refer to **Section 5.11.6.1** for potential direct impacts) and no incremental drawdown is expected Clematis sandstone (SLR 2023c). As such, impacts to any stygofauna in these units are expected to be minor. The Rangal Coal Measure outcrops are within areas to be mined and do not extend to the west (refer to **Section 5.11.6.1** for potential direct impacts). To the east of the Project, the Rangal Coal Measures and Burngrove Formation are deep (>150 m bgl), confined and very unlikely to provide stygofauna habitat and as such potential impacts are not relevant.

Maximum predicted incremental drawdowns to the Tertiary and weathered zones are largely confined to near the pit and influenced by the distribution of predicted saturated zones. Cumulative drawdown impacts within the weathered zone connect to the drawdown in the

Tertiary Sediments and are expected to extend to Blackwater Creek (laterally at depth, not vertically into the shallow formations, such as alluvium or tertiary). Changes in groundwater levels from incremental drawdown are <5 m outside the Project area and changes from cumulative drawdown are generally <10 m, although there are small areas expected to change by >20 m within the ML (**Figure 5.3**; SLR 2023c). Groundwater quality is typically saline in the Tertiary Sediments, and as such stygofauna are unlikely to occur in these zones and potential impacts are unlikely.

Maximum incremental drawdown in the Burngrove Formation to the west of the Project is generally limited in extent to near the pit due to the structural geology. Maximum cumulative drawdown extends to the outcrops of the Burngrove Formation to the west. This drawdown is expected to be 10 to 20 m in very close proximity to the ML, with drawdown decreasing with distance from the ML (**Figure 5.3**; SLR 2023c). Given the limited extent of potential impacts and low likelihood of stygofauna occurring, potential impacts are unlikely.

5.11.6.3 Groundwater Quality

Many stygofauna taxa have strict water quality requirements to survive, and therefore require stable conditions within a narrow physico-chemical range. Although they can tolerate fluctuations in water quality to a certain extent, major changes in water chemistry (e.g. due to pollution plumes) can directly impact the biodiversity and community composition of stygofauna (Eamus et al 2005). Changes to water quality (including any increased concentrations of salts or contaminants associated with mining) of groundwater systems have the potential to impact stygofauna communities. Impacts to groundwater quality may result from saline or acid drainage, seepage, tailings disposal, hazardous and dangerous goods storage, and hydrocarbon and chemical spills (e.g. from fuels, lubricants and oils required for the operation of vehicles and machinery). Where these are managed in accordance with existing management plans and the EA, any impacts are expected to be low risk.

5.11.6.4 Groundwater Interactions

Groundwater systems require connectivity to the surface to provide organic matter and oxygen. Organic carbon in aquifers is sourced externally due to the lack of photosynthesis and enters the aquifers through recharge waters passing through shallow geological units (Nevill et al 2010). If this connection is disrupted and nutrients and oxygen are not replenished, habitat condition declines and stygofauna communities can be indirectly impacted over time.

Stygofauna are highly endemic due to the natural hydrological barriers within aquifer matrices that can restrict their movement. While natural barriers lead to genetic diversity, artificial barriers created by rapid changes in water level or chemistry can limit connectivity between aquifers and prevent dispersal or recolonization of the habitat following disturbances.

Changes to the interactions between groundwater systems, and between groundwater and surface systems can indirectly impact stygofauna communities. Impacts to groundwater interactions may result from reduced catchment area, vegetation clearing, decreased and / or increased surface flows, surface sealing and / or compaction, and backfilling and rehabilitation works. Areas potentially impacted by vegetation clearing, surface

sealing / compaction, backfilling and rehabilitation works are within the Project area where stygofauna are unlikely to occur. As such, any potential impacts are expected to be low risk.

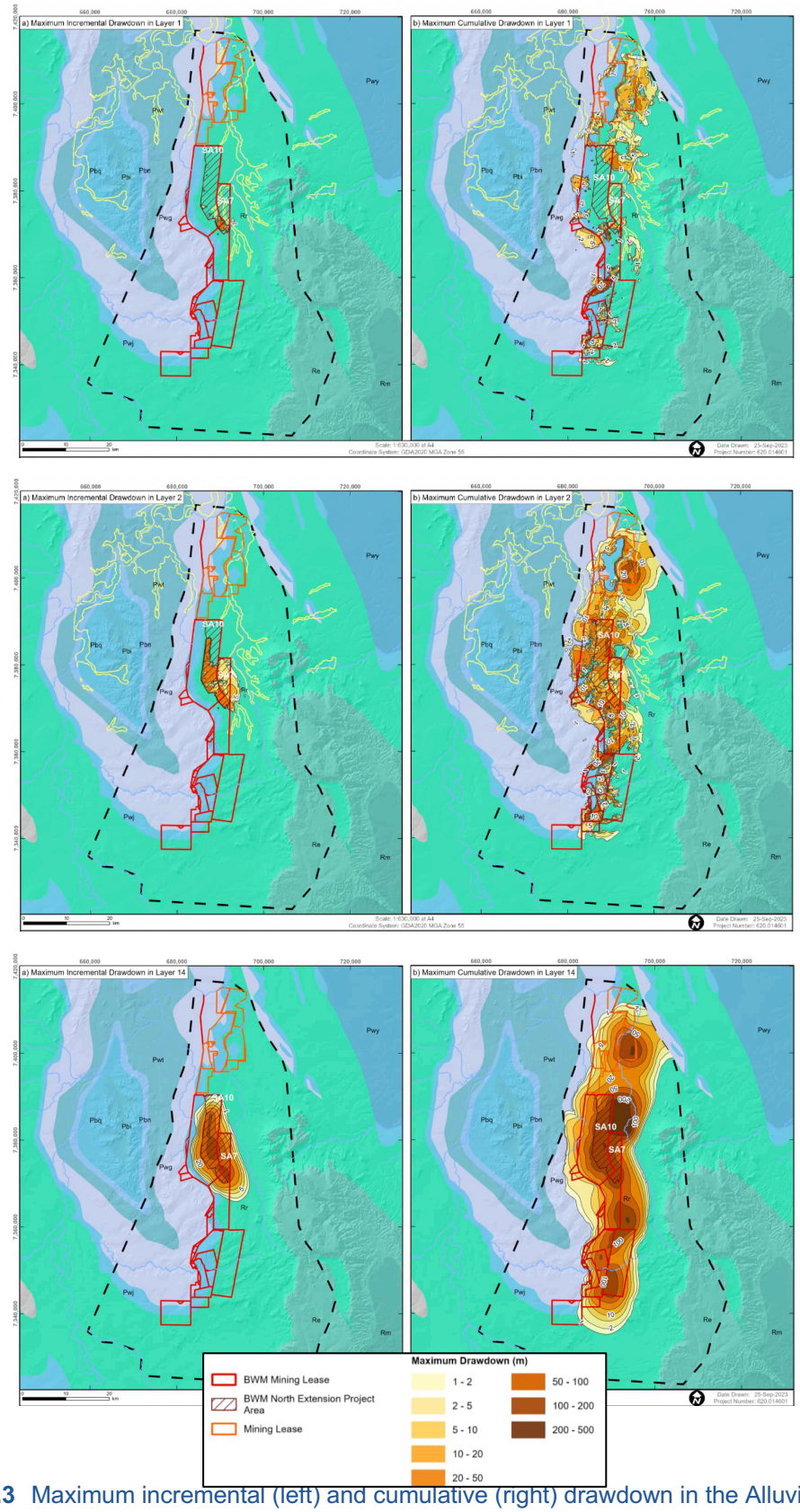

Figure 5.3 Maximum incremental (left) and cumulative (right) drawdown in the Alluvium and Tertiary (top), Alluvium and Weathered Zone (middle) and Burngrove Formation (bottom). Source: SLR 2023c

5.12 Final Landform

Final landform modelling for the Project indicates that the final landform will be stable and flood flows will be free draining (SLR 2023a). At the conclusion of mining final voids will remain, which will be sinks and are not predicted to overflow into the environment (SLR 2023a). Results of the flood modelling indicate that the proposed final landform will provide flood immunity for the final void up to the 0.1% AEP event. The final landform will be safe, stable and non-polluting.

5.13 Matters of National Environmental Significance

Direct impacts to waterway and wetland water resources from the Project are restricted to the Project footprint, which includes low stream order and low value waterways and wetlands (farm dams). This is not expected to impact aquatic ecology on a regional scale, but rather on a localised scale within the Project footprint. Potential adverse impacts to aquatic ecosystem function as a result of changes to hydrology or water quality are predicted to be low risk. Provided the appropriate mitigation and management measures are implemented to maintain downstream water quality (e.g. maintain compliance with existing EA conditions, including the REMP, Waste Management Plan, Water Management Plan and Erosion and Sediment Control Plan), potential adverse impacts to downstream waterways and wetlands are expected to be low risk as a result of the Project.

No surface expression GDEs occur in the Project area (SLR 2023c). Further downstream, Blackwater Creek is a mapped moderate potential GDE, but changes to groundwater from the Project are expected to be insignificant and within the bounds of model error (SLR 2023c). There are no known records of true stygofauna (stygobitic or stygophilic fauna) within or in the vicinity of the Project (DES 2023c, Freshwater Ecology 2021, frc environmental 2020, State of Queensland 2014, State of Queensland 2012). Groundwater units in the Project area provide limited suitable habitat for stygofauna due to the limited saturation, limited connectivity, and either unsuitable or only potentially suitable groundwater quality (electrical conductivity levels outside the preferred range for stygofauna). As such, potential impacts to stygofauna are unlikely.

There were no aquatic MNES flora or fauna species recorded within the Project area, and they are highly unlikely to occur given the lack of suitable habitat available.

5.14 Matters of State Environmental Significance

The character, resilience and values of waterways and wetlands will be managed and monitored to protect EVs of the receiving environment. Waterways that would be directly removed for mining within the Project footprint are mapped as having low and moderate risk of impact to fish passage in the *Waterway Barrier Works* mapping layer. While the Project would remove these ephemeral low value waterways and moderate value wetlands (i.e. farm dams) providing fish habitat within the Project footprint, it would not fragment fish habitat as they do not connect to fish habitat further upstream. A dragline crossing over Deep Creek (mapped as high impact to fish passage) will be constructed at bed level to allow fish passage, and crossings will only occur in the dry. The infrastructure crossing of Taurus Creek, which will include a Back Access Road, is located where it is mapped as a major risk

of impact to fish passage. The waterway at this crossing is ephemeral, moderate ecological value (with fauna common in the region) and there are existing limitations to fish passage further upstream (onstream dams). Fish passage at this crossing will be maintained by designing culverts in general accordance with the ADR for high risk waterway barrier works (DAF 2020) and the Department of Transport and Main Roads Drainage Manual (TMR 2023). The MSES Significant Residual Impact (SRI) assessment for waterways providing fish passage in accordance with the *Queensland Environmental Offsets Policy, Significant Residual Impact Guideline* (DEHP 2014) is provided in **Table 5.2** and concludes the Project will not have a significant impact on fish passage where the appropriate design, management and mitigation measures are effectively implemented.

No HES wetlands or HEV waterways are present within the Project area or in the vicinity of the Project. There were no aquatic MSES flora or fauna species recorded within the Project area, and they are highly unlikely to occur given the lack of suitable aquatic habitat. Therefore, no direct or indirect impacts to these species as a result of the Project are expected.

Table 5.2 Significant Residual Impact (SRI) assessment for waterways providing for fish passage

SRI Criteria (DEHP 2014)	Assessment for the Project
An action is likely to have a significant impact on a waterway providing for fish passage if there is a real possibility that it will:	
result in the mortality or injury of fish; or	Waterways and farm dams within the Project footprint (mapped as low and moderate waterway barrier works risk) will be removed. These waterways are dry for most of the year and therefore do not support fish for most of the year. Injury or mortality of native fish will be reduced by implementing a fish salvage program before farm dams are dewatered and disturbed. Larger order waterways (order 3 and above), including riparian zones, will not be disturbed by the Project. Two waterway crossings are proposed: a dragline crossing (up to 50 m wide) of Deep Creek (mapped as high waterway barrier works risk); and an infrastructure crossing of Taurus Creek (mapped as major waterway barrier works risk). Crossings have been designed to allow for fish passage. Where the design and mitigation measures outlined in **Section 5.2** are implemented effectively, direct mortality or injury of fish is not expected.
result in conditions that substantially increase risks to the health, wellbeing and productivity of fish seeking passage such as through the depletion of fishes energy reserves, stranding, increased predation risks, entrapment or confined schooling behaviour in fish; or	Waterways and farm dams within the Project footprint will be permanently removed through progressive and staged mining, which will not result in fragmentation of upstream waterways (given the lack of fish habitat further upstream). Larger waterways (stream order 3 and above) downstream are being retained. The two waterway crossings will be designed to allow for fish passage. As such, the Project will not result in conditions that substantially increase risks through the depletion of fishes energy reserves, stranding, increased predation risks, entrapment or confined schooling behaviour in fish.
reduce the extent, frequency or duration of fish passage previously found at a site; or	Waterways within the Project footprint will be removed (the extent, frequency, and duration of fish passage within the Project footprint is minimal due to the highly ephemeral nature and low ecological value of the waterways). The extent, frequency, or duration of fish passage outside the Project footprint will not be disturbed by the Project, including allowing for fish passage in the design of the two waterway crossings.
substantially modify, destroy or fragment areas of fish habitat (including, but not limited to in-	Removal of waterways and farm dams within the Project footprint will destroy areas of fish habitat, but given these waterways are dry (and as such don't provide fish habitat) for most of the year and are of low

SRI Criteria (DEHP 2014)	Assessment for the Project
stream vegetation, snags and woody debris, substrate, bank or riffle formations) necessary for the breeding and/or survival of fish; or	ecological value, this is not considered a substantial impact, but rather a localised impact to fish habitat. These waterways do not connect to important fish habitat upstream, and as such, the removal would not fragment fish habitat further upstream. The two crossings will not destroy or fragment areas of fish habitat where the mitigation measure outlined in **Section 5.2** are implemented effectively, including designing the Taurus Creek Back Access Road crossing in general accordance with the ADR for high (red) risk Operational Work that is Constructing or Raising Waterway Barrier Works (DAF 2020) and the Department of Transport and Main Roads Drainage Manual (TMR 2023); and, constructing the dragline crossing at bed level, with no construction and crossing events scheduled during stream flow. While these aquatic habitats (e.g. woody debris and detritus) occur in some areas in the Project area (EMM 2023a), they are generally limited. As such, removal of waterways and farm dams, and the two waterway crossings are unlikely to modify downstream fish habitat (i.e. the Project area is unlikely to be an important source of habitat features, such as woody debris).
result in a substantial and measurable change in the hydrological regime of the waterway, for example, a substantial change to the volume, depth, timing, duration and frequency of flows; or	Changes in flow due to the release of MAW, construction of flood protection levees and landforms, and due to changes in groundwater are expected to be minimal. Changes in flow due to catchment loss are expected to be minimal due to the ephemeral nature and infrequent flow regimes of the creeks. The potential impact on water flow in Blackwater Creek at the confluence with Taurus Creek and further downstream at the town of Blackwater is likely to be undetectable (SLR 2023a). Based on the Project footprint (i.e. the maximum disturbance area), the change to the estimated flow exceedance at the 50th, 80th and 90th percentiles is < 10%, except for Sagittarius Creek at the ML Boundary, which is expected to decrease by 11% for the 90th percentile flow exceedance (SLR 2023a). As such, the changes in flow due to loss of catchment area are acceptable (in accordance with the general presumptive standards outlined in Richter et al 2011) for the low to moderate aquatic ecosystem value waterways downstream of the Project, and changes in hydrological regimes of the waterways will not be substantial.
lead to significant changes in water quality parameters such as temperature, dissolved oxygen, pH and conductivity that provide cues for movement in local fish species	The risk of adverse impacts to the water quality downstream of the Project is minimal where the proposed mitigation and management strategies for surface water outlined in the *Surface Water Impact Assessment* are effectively implemented (SLR 2023a). As such, the Project is not expected to lead to significant changes in water quality parameters such as temperature, dissolved oxygen, pH and conductivity that provide cues for movement in local fish species.

6 Risk Assessment

6.1 Risk Assessment and Mitigation Measures

Risks of potential impacts were assessed according to the criteria outlined in **Table 6.1**, **Table 6.2** and **Table 6.3**. The unmitigated risks were assessed as well as the mitigated risks. The outcomes of the assessments, including a summary of the appropriate mitigation measures, are presented in **Table 6.4**.

Table 6.1 Risk matrix, including likelihood of an impact occurring, and the severity of subsequent consequences

Likelihood of Consequence	Severity of Consequence						
	Insignificant	**Minor**	**Moderate**	**Major**	**Serious**	**Severe**	**Permanent Severe**
Almost Certain	Low	Medium	High	Very High	Very High	Very High	Very High
Likely	Low	Medium	High	High	Very High	Very High	Very High
Possible	Low	Medium	Medium	High	High	Very High	Very High
Unlikely	Low	Low	Medium	Medium	High	High	Very High
Rare	Low	Low	Low	Medium	Medium	High	High
Very Rare	Low	Low	Low	Low	Medium	Medium	High

Table 6.2 Definitions of likelihood for the risk assessment

Level of Likelihood	Definitions
Almost certain	The event is expected to occur in most circumstances (the event is expected to occur multiple times a year or incident is clearly imminent).
Likely	The event will probably occur in most circumstances (the event is expected to occur approximately once per year).
Possible	The event may occur at some time (the event is likely to occur approximately once every five years).
Unlikely	The event is not expected to occur (the event is likely to occur approximately once every five to 10 years).
Rare	The event may occur only in exceptional circumstances (the event is likely to occur approximately once every 10 to 20 years).
Very rare	The event may occur only in highly exceptional circumstances (the event is likely to occur less than once every 20 years).

Table 6.3 Definitions of consequence for the risk assessment

Severity of Consequence	Definitions
Permanent severe	Extensive long-term environment harm and / or harm that is extremely widespread. Impacts considered to be permanent.
Severe	Extensive long-term environment harm and / or harm that is extremely widespread. Damage caused may take more than 20 years to recover
Serious	Serious or widespread major effect. Significant resources required to respond and rehabilitate, and damage caused may take 15 to 20 years to recover with long-term evidence of the incident resulting.
Major	Major or widespread moderate effect. Significant resources required to respond and rehabilitate, and damage caused may take 10 to 15 years to recover with long-term evidence of the incident resulting.
Moderate	Localised, short-term to moderate unplanned environmental impact. Moderate but repairable damage that may take up to 10 years to recover.
Minor	Localised short-term effect. Minor environmental impact that is contained on-site. It will take less than two years for the asset to fully recover or it will only require minor repair.
Insignificant	No impact or no lasting effect. Negligible damage that is contained on-site and is fully recoverable with no permanent effects, taking less than six months to fully recover.

Table 6.4 Risk assessment and proposed mitigation measures

Potential Impact	Potential Impacts to the Aquatic Ecosystem	Mitigation Measures	Risk (Unmitigated)	Risk (Mitigated)
Loss of aquatic habitat resulting in removal of aquatic flora and fauna species.	Direct and permanent loss of available aquatic habitat associated with tributaries of Sagittarius Creek, Deep Creek, Taurus Creek and Two Mile Gully, a section of the upper reaches of Sagittarius Creek and lacustrine wetlands (farm dams). The waterways are highly ephemeral and considered to be habitat types common to the region and have low aquatic ecological value. The farm dams provide a dry season refuge for aquatic flora and fauna and are of moderate aquatic ecological value.	Avoid major waterways (stream order 3 and above). Salvage and translocate large native aquatic fauna (e.g. fish and turtles) from wetlands and farms dams prior to removal, where possible. Limit the area disturbed at any one time; progressive and timely reinstatement of the disturbed landform; and grading the finished surface slopes of all re-shaped landforms to allow for natural runoff to drain freely.	Likelihood: Almost certain Consequence: Minor **Risk: Medium**	Likelihood: Almost certain Consequence: Insignificant **Risk: Low**
Modification aquatic habitat resulting in removing sources of habitat material downstream resulting in reduced habitat available to aquatic fauna.	Reduce or limit aquatic habitat (e.g. woody debris, tree roots or undercut banks) available to fauna in downstream areas (as the source of habitat material is removed). Project footprint is likely to provide very limited aquatic habitat to downstream areas and unlikely to be significantly impacted.	None.	Likelihood: Almost certain Consequence: Insignificant **Risk: Low**	NA
Loss of the waterways or waterway crossings preventing or restricting movement of fish.	Loss of fish passage to mapped low and moderate waterways within the Project footprint. The Project would remove these waterways and wetlands providing fish habitat, but would not fragment fish habitat as they do not connect to fish habitat further upstream. Installation of waterway crossings (infrastructure crossing and dragline crossing) on mapped high and major risk waterways impacting on fish passage.	Measure as outlined above for loss of aquatic habitat. Design waterway crossings to consider fish passage and flow, including in general accordance with ADR requirements of a high-risk waterway barrier works for the Back Access Road. Dragline crossing will be at creek bed level and will not restrict flow. The upstream and downstream edges of the crossings will be protected by rock. Dragline crossing events will be infrequent and will be scheduled during wet weather or stream flow.	Likelihood: Almost certain Consequence: Moderate **Risk: High**	Likelihood: Almost certain Consequence: Insignificant **Risk: Low**

Potential Impact	Potential Impacts to the Aquatic Ecosystem	Mitigation Measures	Risk (Unmitigated)	Risk (Mitigated)
Changes in flow or surface water hydrology influencing aquatic habitat and communities downstream.	Loss of catchment area may reduce downstream flow causing localised changes to habitat and biotic communities downstream. Changes in flow are expected to be within acceptable levels for the low to moderate aquatic ecosystems in the area. All water releases will occur in compliance with existing EA Conditions.	Limiting the area disturbed at any one time, which minimises the area of catchment loss; progressive and timely re-instatement and rehabilitation of the disturbed landform where practical.	Likelihood: Almost certain Consequence: Minor **Risk: Medium**	Likelihood: Almost certain Consequence: Insignificant **Risk: Low**
Decreased bank stability, increased erosion and stormwater runoff influencing water quality downstream.	Reduced water quality, including high suspended sediments, sedimentation, turbidity, and nutrients concentrations. Potential impacts to health, composition and resilience of flora and fauna; respiration and feeding of fauna; reduce growth and diversity in aquatic plants and algae; and/or bury benthic communities.	The BWM Erosion and Sediment Control Plan and BWM Water Management Plan will be reviewed and updated, where required to include the Project; monitoring of downstream water quality (REMP and FRREMP); construction of waterway crossings will not be scheduled to occur during wet weather or stream flow; areas which are not required for the ongoing operation of the Project to be rehabilitated as soon as practicable to reduce exposed soils; implementation of management measures to minimise the potential risk of spills or leaks.	Likelihood: Possible Consequence: Moderate **Risk: Medium**	Likelihood: Unlikely Consequence: Minor **Risk: Low**
Release of MAW or sediment-laden water resulting in declines in water and sediment quality downstream.	Direct impacts to water quality and sediment quality and indirect impacts to aquatic habitat, flora and fauna in the receiving environment. MAW released through the BWM water management system will be managed in accordance with the requirements of the EA. Ongoing water quality monitoring will continue in accordance with the current EA REMP condition to ensure downstream water quality is not adversely impacted. Previous REMP results generally indicate release water quality is within acceptable limits for slightly to moderately disturbed systems.	Designing water management infrastructure and structures in accordance with the water management strategy and EA; expanding the existing Mine Water Management Plan to incorporate the construction and operational phase of the Project; expanding the current REMP to incorporate the construction, operation and decommissioning phases of the Project; manage MAW releases in accordance with the existing EA.	Likelihood: Likely Consequence: Minor **Risk: Medium**	Likelihood: Likely Consequence: Insignificant **Risk: Low**

Potential Impact	Potential Impacts to the Aquatic Ecosystem	Mitigation Measures	Risk (Unmitigated)	Risk (Mitigated)
Dust and particulate matter entering waterways and influencing water quality, potentially impacting aquatic habitat value, flora and fauna.	Dust from increased mining activities may enter waterways and increase turbidity, sedimentation, nutrients and contaminants (e.g. from mining waste) in downstream and / or adjacent waterways, potentially reducing aquatic ecosystem value and directly and indirectly impacting flora and fauna.	Managed under the existing EA requirements and Air Emissions Management Plan.	Likelihood: Possible Consequence: Moderate **Risk: Medium**	Likelihood: Unlikely Consequence: Minor **Risk: Low**
Saline and acid mine drainage surface water run-off or seepage resulting in declines in water quality.	Potential saline and acid mine drainage surface water-runoff or seepage that could influence water quality.	Continuation of current spoil management in accordance with the EA.	Likelihood: Unlikely Consequence: Moderate **Risk: Medium**	Likelihood: Unlikely Consequence: Minor **Risk: Low**
Leaks and spills of hydrocarbons and other contaminants resulting in declines in water quality or direct toxicity to aquatic flora and fauna.	Direct impact to water quality and indirect impacts to aquatic ecology in the receiving environment (e.g. toxicity to flora and fauna).	Implement measures outlined in existing BWM Waste Management Plan*;* appropriate storage of chemicals and hydrocarbons; implementation of appropriate containment and spill response procedures and, ensure refueling location and handling of fuels are undertaken away from waterways.	Likelihood: Possible Consequence: Moderate **Risk: Medium**	Likelihood: Unlikely Consequence: Minor **Risk: Low**
Litter and waste resulting in reduces habitat quality and mortality of aquatic fauna.	Potentially be ingested by fauna; entangle or entrap aquatic flora and fauna and / or negatively impact water quality.	Implement measures outlined in existing BWM Waste Management Plan, BWM Erosion and Sediment Control Plan and consistent with EA requirements.	Likelihood: Possible Consequence: Moderate **Risk: Medium**	Likelihood: Unlikely Consequence: Minor **Risk: Low**
Introduction of invasive species reducing habitat quality and availability for native aquatic species.	Changes in community structure and general health of aquatic fauna and flora in downstream and / or adjacent waterways.	Implement weed management measures outlined in BWM Land and Biodiversity Management Plan. Existing weed hygiene protocols to continue to be implemented for vehicles and machinery.	Likelihood: Possible Consequence: Moderate **Risk: Medium**	Likelihood: Unlikely Consequence: Minor **Risk: Low**

Potential Impact	Potential Impacts to the Aquatic Ecosystem	Mitigation Measures	Risk (Unmitigated)	Risk (Mitigated)
Changes to groundwater influencing water quantity and quality, and groundwater interactions.	Changes to water quality and quantity can limit favourable surface expression GDE and subterranean aquatic habitat available for stygofauna communities. No surface expression GDEs occur in the Project area. Further downstream, Blackwater Creek is a mapped moderate potential GDE, but changes to groundwater from the Project are expected to be insignificant and within the bounds of model error (SLR 2023c). Groundwater units in the Project area provide limited suitable habitat for stygofauna, and as such, potential impacts to stygofauna are unlikely.	Groundwater monitoring in accordance with the EA and associated plans.	Likelihood: Unlikely Consequence: Moderate **Risk: Medium**	Likelihood: Unlikely Consequence: Minor **Risk: Low**
Final landform could impact flow and water quality of the receiving environment.	The final landform will be stable and flood flows will be free draining. At the conclusion of mining final voids will remain, which will be groundwater sinks and are not predicted to overflow into the environment.	Final landform that is safe, stable and non-polluting.	Likelihood: Possible Consequence: Moderate **Risk: Medium**	Likelihood: Unlikely Consequence: Minor **Risk: Low**

7 Summary and Conclusions

Aquatic habitat in waterways and wetlands in the vicinity of the Project is typical of ephemeral systems in the broader region, with seasonal patterns in habitat availability and quality. Waterways were generally dry during the baseline assessments, with isolated dry season refuges were recorded at farm dams (lacustrine wetlands) and a flood channel wetland.

Water quality in waterways and wetlands in the vicinity of the Project was highly variable, which is typical of ephemeral systems in the region. Overall, water quality measured in situ in the REMP was characterised by neutral pH, low electrical conductivity and variable saturation of dissolved oxygen. Laboratory-analysed results also indicated moderate to high concentrations of nutrients and total suspended solids, but a low concentration of ions and metals (although concentrations of dissolved copper, and total aluminium, iron and manganese can be high). Water quality measured in the farm dam and wetland sites during the baseline assessment were mildly to strongly alkaline, had a relatively high electrical conductivity, variable dissolved oxygen concentration and moderate to high turbidity. Hardness generally indicated moderate to extremely hard waters, and ion concentrations generally indicative of bicarbonate waters. Sediment quality was generally good in the vicinity of the Project. Concentrations of metals were typically suitable to protect the moderate aquatic ecosystem value, and likely influenced to some degree by surrounding land use and local geomorphology.

Biological communities (including aquatic plants, macroinvertebrates, macrocrustaceans, fish and turtles) recorded at sites in the Project area were typical of ephemeral systems in central Queensland. All taxa recorded were common in the broader region, and no listed threatened species known from the catchment (or potential habitat for these species) were identified.

Emergent growth forms dominated aquatic plant communities, with few submerged and floating species, indicating that water is not likely to persist for the majority of the year (except at farm dams). Three species listed as priority flora have been recorded in low cover on Taurus Creek (stream order 4). Four introduced aquatic plants, none of which are WoNS, are know from the sub-basin and two of these have been recorded in the vicinity of the Project, namely white eclipta and awnless barnyard grass.

Macroinvertebrate communities sampled in the baseline surveys were in poor to moderate condition relative to those expected in the broader region, with few sensitive taxa. Results indicated unfavourable physical conditions and / or reduced habitat quality, likely reflecting seasonality and the ephemeral nature of waterways in the region, rather than catchment impacts. Long-term monitoring as part of the REMP indicated communities are typically dominated by common taxa that are tolerant of harsh physical conditions. There has been no indication from the REMP results that mining has had a negative influence on the health of macroinvertebrate communities. Macroinvertebrate communities at sites downstream of BWM on higher stream orders were often in better condition than those upstream.

During the baseline surveys, nine species of common native fish were caught. Fish communities were dominated by small bodied species, with the lack of large-bodied fish likely due to the paucity of deep pool habitat. Two restricted noxious fish under the *Biosecurity Act 2014* have been recorded in the region, namely tilapia and mosquitofish.

Turtles were not particularly abundant or widespread in the vicinity of the Project and were only caught in one of the farm dams on Sagittarius Creek. The species captured (eastern snake-necked turtle) is widespread and common throughout waterways in Queensland. Six other species of freshwater turtles occur in the sub-basin. There was no suitable habitat for platypus found in the Project area, and the nearest record is approximately 30 km to the east of the Project area.

There are no known surface expression Groundwater Dependent Ecosystems (GDEs) mapped within the Project area. The baseline survey results indicated there was no obvious groundwater influence within the Project area, including no flows, salt seeps, hydrophytes, or other aquatic GDE indicators following prolonged dry conditions, and no obvious groundwater influence on the concentrations of major anions and cations in surface water. One aquatic system, Blackwater Creek, (located outside of the Project area to the north-east and downstream) is mapped as having moderate potential for groundwater interaction. While surveys have not been completed in this watercourse, desktop assessments indicate a moderate aquatic ecological value. This is similar to other waterways in the region that are not mapped as GDEs.

Of the aquatic listed threatened species known to occur in the broader catchment, none were considered likely to occur in the vicinity of the Project. Waterways in the vicinity of the Project are mapped as waterways providing for fish passage in the *Waterway Barrier Works* spatial layer, a MSES, with a low, moderate, high and major risk of adverse impacts to fish passage as a result of waterway barrier works. Water resources occur within the vicinity of the Project, which are a MNES in relation to coal seam gas and large coal mining development. These included: waterways (all of which were ephemeral in nature) and lacustrine wetlands and farm dams (likely modified by the presence of dams), palustrine wetlands (upstream of the Project), mapped potential aquatic GDEs. No other aquatic MNES or MSES were identified within the vicinity of the Project.

Overall, aquatic ecosystem values of waterways and wetlands in the vicinity of the Project were low to moderate, and were considered to be similar to and representative of ephemeral systems in the broader region. Waterways with higher stream orders (i.e. stream order 3 and above) typically had higher ecological value than sites on waterways with low stream orders (i.e. stream order 1 and 2). Wetlands were assessed as having moderate aquatic ecological value (particularly due to their provision of dry season refuge for aquatic flora and fauna).

Direct impacts to waterways and wetlands (water resources) from the Project are restricted to the Project footprint, which includes low stream order and low value waterways and wetlands (farm dams). This is not expected to impact aquatic ecology on a regional scale, but rather on a localised scale within the Project footprint. Changes to the net groundwater flow to Blackwater Creek (moderate potential for groundwater interaction) due to the Project are expected to be minor. Groundwater aquifers impacted by the Project have a low likelihood of supporting stygofauna communities, and as such, potential impacts to stygofauna are unlikely.

The character, resilience and values of waterways and wetlands will be managed and monitored to protect EVs of the receiving environment. Releases of Mine Affected Water will occur in compliance with the existing Environmental Authority (EA) conditions, and existing BWM management plans (including the BWM Water Management Plan, Erosion and Sediment Control Plan, Waste Management Plan, Air Emissions Management Plan and

Progressive Rehabilitation Closure Plan [to be developed]), which will be reviewed and updated, if required, to incorporate the Project. The Project is expected to have a minor impact on streamflow or flood flows, and as such, potential impacts on aquatic ecology are expected to be of low risk.

The majority of waterways within the Project footprint are mapped as having low and moderate risk of impact to fish passage in the *Waterway Barrier Works* mapping layer. While the Project would remove these ephemeral low value waterways and moderate value wetlands providing fish habitat within the Project footprint, it would not fragment fish habitat as they do not connect to fish habitat further upstream. A proposed dragline crossing over Deep Creek (waterway mapped as high risk of impact to fish passage) will be constructed at bed level to allow fish passage, and crossings will only occur in the dry. An infrastructure corridor crosses Taurus Creek, where it is mapped as a major risk of impact to fish passage. The waterway at this crossing is ephemeral, moderate ecological value (with fauna common in the region) and there are existing limitations to fish passage further upstream (onstream dams). Fish passage at this crossing will be maintained by designing culverts in general accordance with the Accepted Development Requirements for high risk waterway barrier works and the Department of Transport and Main Roads Drainage Manual.

Pest species in the region include two restricted fish and introduced weeds. Weed management (prevention, monitoring and control) will be undertaken to minimise the potential for an increase in abundance and/or species of weeds. Standard weed hygiene protocols will be implemented (in accordance with the existing BWM Land and Biodiversity Management Plan), and as such risks are expected to be minor.

Overall, where mitigation and management measures are effectively implemented, potential impacts from the Project are of low risk to aquatic ecosystem values.

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Attachment A Aquatic Ecology Baseline Assessment (EMM 2023a)

Aquatic Ecology Baseline Assessment

Blackwater Mine - North Extension Project

Prepared for BM Alliance Coal Operations Pty Ltd

July 2023

Aquatic Ecology Baseline Assessment

Blackwater Mine - North Extension Project

BM Alliance Coal Operations Pty Ltd

B210051 RP2

July 2023

Version	Date	Prepared by	Approved by	Comments
V1	4 March 2021	David Moore	Berlinda Ezzy	
V2	18 July 2023	Justin Chey	Berlinda Ezzy	Updated to address BMA comments

Approved by

Berlinda Ezzy
Associate Director
18 July 2023

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Executive Summary

BM Alliance Coal Operations Pty Ltd (BMA) owns and operates the Blackwater Mine (BWM), situated approximately 20 kilometres (km) south of Blackwater, Queensland. The mine has been in operation since the 1960s and currently operates under an Environmental Authority (EA) EPML00717813, with existing coal production at c.16 million tonnes per annum (Mtpa).

BMA is planning an expansion of its current mining footprint to the east of the existing operation. EMM Consulting Pty Limited (EMM) were commissioned by BMA to undertake seasonal aquatic ecology surveys and assessments across the proposed mine expansion areas defined as the BWM North Extension Project. The study area assessed is shown in Figure 1.1.

This aquatic ecology survey report aims to describe the aquatic values of the BWM North Extension Project area referred to as study area, identify any conservation significant species under the Queensland *Nature Conservation Act 1992* (NC Act) and Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), to identify the potential for aquatic groundwater dependent ecosystems (GDEs) to occur, and to identify and describe any Matters of State or National Environmental Significance that may occur in the study area (relating to aquatic ecology) based on desktop assessments and seasonal surveys undertaken in December 2019 and May 2020. The broader desktop assessment area, as applied in desktop searches, comprises of a 25 km buffer from a central point in the study area.

The waterways of the study area range from small first order tributaries to larger fourth order streams being: Two Mile Gully and Taurus Creek. Other named waterways in the study area include Sagittarius and Deep Creek. Mapped wetlands in the study area are limited to one lacustrine wetland waterbody (farm dam). A number of smaller, unmapped lacustrine wetland waterbodies (farm dams and a flood channel wetland) also occur. The waterways of the study area are ephemeral and are generally expected to experience flow only after sustained or intense rainfall and runoff in the catchment. Stream flows are expected to be highly variable, with most channels expected to dry during winter to early spring when rainfall and runoff is lower. Consequently, physical attributes, water quality, and the composition of aquatic flora and fauna communities are expected to vary seasonally.

Aquatic survey was attempted at nine locations in December 2019, comprising seven waterways, and two lacustrine wetland waterbodies. With most waterways being dry at the time of assessment, habitat assessments were undertaken in place of detailed aquatic survey at most riverine sites. Most lacustrine waterbodies (farm dams) held water at the time of assessment. The same sites were again sampled in May 2020 to capture a complete seasonal dataset. An additional site, site RW1 – being an unmapped flood channel wetland on Taurus Creek – was opportunistically sampled in May 2020 due to the persistence of wetted habitat that was not encountered in this area in December 2019. In total, 10 aquatic sites were surveyed.

Overall aquatic values across the study area ranged from low to moderate aquatic values. Riverine sites on Sagittarius, Taurus Creeks and Two Mile Gully were rated as having moderate aquatic values due largely to their importance as conduits for fish passage. Riverine sites with a stream order 1-2 were rated as having low aquatic values. Wetland waterbody sites L1 and L2 were rated as having moderate aquatic values, considering their suitability as dry season refuge for Least Concern fish and turtle species.

Aquatic macroinvertebrate indices, including taxa richness, PET richness, SIGNAL2, tolerant taxa and AusRivAS scores, were variable, likely reflecting seasonality more than catchment impacts.

Fish, macroinvertebrates and turtles were surveyed at wetted sites, including isolated pools on Taurus Creek (site R4), a flood channel wetland on Taurus Creek (site RW1), and a farm dam (site L1). The sampling effort detected 10 fish species (nine Least Concern native species and one exotic species), one Least Concern turtle species and a diversity of aquatic macroinvertebrates. Flora surveys across all wetted and dry sites detected 20 species of aquatic or semi-aquatic flora (18 Least Concern native species and two introduced species).

No conservation significant aquatic flora or fauna species listed under the NC Act and/or EPBC Act were recorded during survey efforts. Due to a lack of suitable habitat present and distributional range, it is unlikely that any critically endangered, endangered, vulnerable or near threatened (CEEVNT) aquatic flora or fauna species occur within the waterways or wetlands of the study area as either resident or transient occurrences.

There are no Wetlands of International Importance or National Importance identified within the study area.

Matters of State Environmental Significance (MSES) of relevance to this aquatic ecology assessment include waterways providing for fish passage. A waterway providing for fish passage is a MSES only if a waterway barrier work is proposed that would limit the passage of fish along the waterway.

GDEs are a component of the water resource MNES. State mapping indicates no 'known' or 'derived' surface expression GDEs within the study area. Prolonged dry conditions in the lead-up to the December 2019 surveys provided ideal conditions for identifying surface expressions of groundwater (i.e aquatic GDEs). However, no flows, salt seeps, hydrophytes, or other obvious indicators of aquatic GDEs were encountered. Further, the concentration and relative proportion of major anions and cations in surface water samples collected from the survey area in December 2019 and May 2020 showed no obvious groundwater influence. Field verification of riparian vegetation and aquatic habitats of the survey area found no obvious on-ground indicators of aquatic GDEs.

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1 Introduction

1.1 Background

BM Alliance Coal Operations Pty Ltd (BMA) owns and operates the Blackwater Mine (BWM), situated approximately 20 kilometres (km) south of Blackwater, Queensland. The mine has been in operation since 1967 and currently operates under an Environmental Authority (EA) EPML00717813, with existing coal production at c.16 million tonnes per annum (Mtpa).

BMA is planning to extend its approved mining lease (ML) footprint within ML1759 and ML1762 eastward, to mine within Surface Area (SA) 10 on ML1759 and SA7 on ML1762 (Figure 1.1). Mining within these surface areas would require both State and Federal environmental approvals. The extent of SA10 and SA7 are illustrated in Figure 1.1 and represent the 'study area' for this Aquatic Ecology Baseline Assessment.

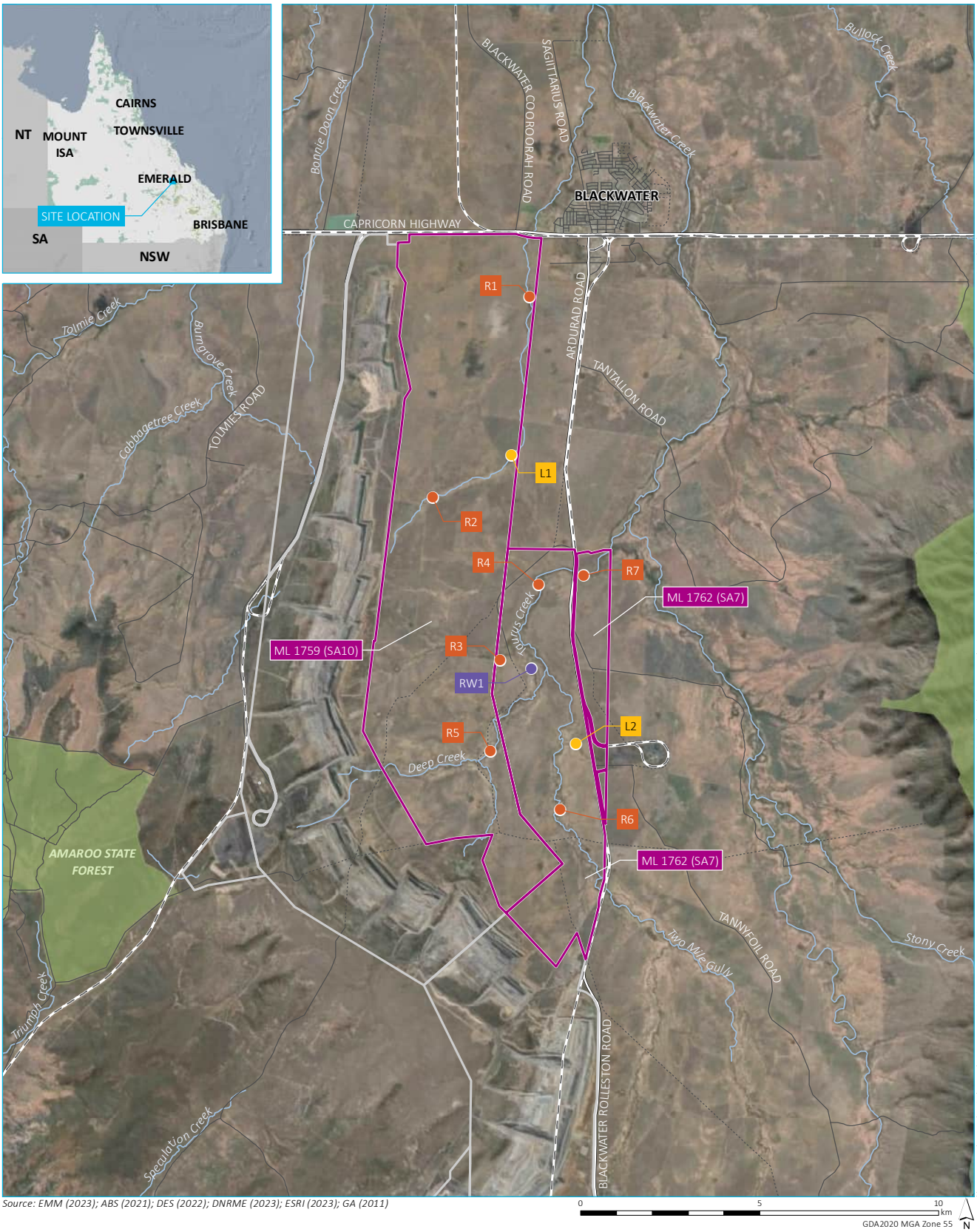
BMA has identified a need for contemporary baseline information on aquatic ecology addressing applicable environmental survey guidelines to support future impact assessments and identify the presence of significant biodiversity values.

1.2 Purpose of this report

The purpose of this report is to describe the aquatic values of the study area as relevant to current Commonwealth and State legislation. The report presents a baseline assessment of aquatic ecological values based on a desktop assessment of available information, and seasonal surveys undertaken in December 2019 and May 2020.

The content of this aquatic ecology baseline assessment is limited to aquatic ecology, including aquatic (surface expression) groundwater dependent ecosystems (GDEs). It does not address subterranean or terrestrial ecology, as these are being addressed in separate EMM studies and reporting. Further, aquatic sites surveyed in the field were concentrated within the s•• • • area, as defined as the BMA Northern E••• • •••• • area (SA7 and SA10).

This aquatic ecology baseline assessment will be used to inform a subsequent impact assessment.



Source: EMM (2023); ABS (2021); DES (2022); DNRME (2023); ESRI (2023); GA (2011)

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KEY

- Study area
- Mining lease surface area

Aquatic sites surveyed

- Riverine drainage system
- Riverine wetland/waterbody
- Lacustrine waterbody

Existing environment

- Rail line
- Major road
- Minor road
- Vehicular track
- Named watercourse
- National park/nature reserve
- State forest

Study area

BMA - Blackwater Mine
Aquatic Ecology Baseline Assessment
Figure 1.1

EMM creating opportunities

2 Legislative context

A summary of the key legislation that has informed the design and implementation of the aquatic ecological assessment is provided in the following sections.

2.1 Commonwealth Environment Protection and Biodiversity Conservation Act 1999

The *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) is the Australian Government's central piece of environmental legislation that provides a legal framework to protect and manage nationally and internationally important flora, fauna, ecological communities and heritage places — defined in the EPBC Act as Matters of National Environmental Significance (MNES).

If a proposed development or other action ('proposed action') is likely to have a significant impact upon a protected matter, then it must be referred for assessment under the EPBC Act. Protected matters under EPBC Act are:

- World Heritage Properties;
- National Heritage Places;
- wetlands of international importance (listed under the Ramsar Convention);
- listed threatened species and ecological communities;
- migratory species protected under international agreements;
- Commonwealth marine areas;
- the Great Barrier Reef Marine Park;
- the environment, where nuclear actions are involved; and
- a water resource, in relation to coal seam gas and large coal mining developments.

The aquatic ecology surveys include assessing the presence, or likely presence, of listed aquatic flora and fauna species under the EPBC Act. The aquatic surveys were designed and implemented with consideration of the Commonwealth survey guidelines for Australia's threatened fish (DSEWPC 2011a) and reptiles (DSEWPC 2011b).

Of the nine MNES that are regulated by the EPBC Act, the following may be applicable to aquatic ecology:

- listed threatened aquatic species and communities;
- Ramsar wetlands of international importance ('Ramsar wetlands'); and/or
- a water resource (which includes GDEs).

2.1.1 Matters of National Environmental Significance - Significant Impact Guidelines 1.1

Under the EPBC Act an action will require approval from the minister if the action has, will have, or is likely to have, a significant impact on a MNES. The *Significant Impact Guidelines 1.1: Matters of National Environmental Significance* (DotE 2013) outline a 'self-assessment' process, including detailed criteria, to assist persons in deciding whether or not referral may be required and if the proposed action may have a 'significant' impact on MNES.

The EPBC Act includes a requirement that where a significant impact to a MNES is assessed as likely to occur, an environmental offset is required to compensate for that impact.

2.2 Queensland Environmental Protection Act 1994 (EP Act)

The Queensland *Environmental Protection Act 1994* aims to promote ecologically sustainable development for the protection of Queensland's natural environment. The EP Act provides a wide range of tools, including Environmental Protection Policies (EPPs), environmental impact assessment process, the establishment of a general environmental duty and, a duty to notify of environmental harm. The EP Act also governs the environmental regulation of mining activities which are authorised and managed through the provision of an EA.

An EA amendment under the Qld EP Act will be required to authorise future mining within SA10 and SA7. Prior to the granting of an EA amendment, an environmental impact assessment is required to be undertaken to assess the potential for environmental impacts, and identify how those impacts will be avoided, reduced and mitigated.

The EA also authorises those Environmentally Relevant Activities (ERAs) that are to be carried out on the mining lease. Schedule 2 of the *Environmental Protection Regulation 2019* (EP Regulation) outlines activities that are ERAs. Another function performed by the EP Regulation allows for the identification of Environmentally Sensitive Areas (ESAs) through the codes of compliance, tenures relating to mining and activities. ESAs are divided into Categories A, B and C. Category A and B ESAs are defined by the EP Regulation, and Category C ESAs are defined in a relevant model conditions document or ERA standard. Category A and B ESAs include:

Category A:

- national park
- conservation park
- special wildlife reserve
- forest reserve
- wet tropics area
- Great Barrier Reef Marine Park
- part of a marine park that is not a general use zone.

Category B:

- coordinated conservation area
- international agreement area (e.g., Bonn, Ramsar)
- critical habitat or major interest area under a conservation plan
- an area subject to an interim conservation order
- the coastal zone (i.e., seaward of the highest astronomical tide)
- a cultural heritage place or a registered place of heritage
- state forest or scientific reserve
- declared fish habitat or a place where a marine plant is situated

- endangered regional ecosystem.

No ESAs relevant to aquatic ecology are identified within the study area. A separate terrestrial ecology report assesses ESAs relevant to terrestrial ecology.

Environmental Protection Policy (EPP) applicable to aquatic ecology is the *Environmental Protection (Water and Wetland Biodiversity) Policy 2019* (EPP (Water and Wetland Biodiversity)). The EPP (Water and Wetland Biodiversity) achieves the object of the EP Act to protect Queensland's waters while supporting ecologically sustainable development. Queensland waters include water in rivers, streams, wetlands, lakes, groundwater aquifers, estuaries and coastal areas. Environmental values (EVs) and water quality objectives (WQOs) are being progressively determined for areas of Queensland. In high ecological value (HEV) areas, WQOs are to be maintained. In slightly disturbed (SD) areas, water quality is to be improved where needed, to achieve WQOs.

2.3 Nature Conservation Act 1992 (NC Act)

The NC Act deals with the legal status and management of native flora and fauna species listed under the *Nature Conservation (Wildlife) Regulation 2006* (NC Regulation) and the *Nature Conservation (Wildlife Management) Regulation 2006*. It prohibits the destruction or removal, unless authorised, of native flora and fauna species in the wild. The NC Act also provides an integrated and comprehensive strategy for conserving nature. Under the NC Act (and the subordinate NC Regulation), protected species are assigned a conservation status of either Extinct in the Wild, Endangered, Vulnerable, Near Threatened (EVNT), Special Least Concern (SLC) or Least Concern (LC).

Aquatic fauna species protected under the NC Act include SLC and LC mammals, EVNT and LC reptiles, and EVNT fishes. LC fishes are protected under the *Fisheries Act 1994*.

A number of LC aquatic flora (Section 5.4) and fauna (Section 5.5) species were recorded from the study area during the aquatic surveys undertaken in December 2019 and May 2020.

2.4 Water Act 2000

The *Water Act 2000* (Water Act) provides a framework for the planning and regulation of use and control of water. Statutory water plans are prepared under the Water Act to advance the responsible and productive management of water. The water planning process addresses general ecological outcomes relating to wetlands. The Water Act also addresses requirements associated with watercourse diversions. No watercourse diversions are proposed.

2.5 Fisheries Act 1994 (Fisheries Act)

The *Fisheries Act 1994* (Fisheries Act) regulates fishing, development in fisheries habitat areas, and damage to marine plants. The Fisheries Act incorporates fish passage and provides legislation to manage developments that may impact on fish passage through activities such as construction of a waterway barrier. The Fisheries Act defines waterway barrier works as a dam, weir, or other barrier across a waterway, if the barrier limits fish stock access and movement along a waterway.

Mining activities authorised under the *Mineral Resources Act 1989* are exempt from requirements under the *Planning Act 2016*, including the requirements for obtaining waterway barrier works development approvals. However, impacts of exempt waterway barrier works associated with mining activities on fish movement are managed through conditions imposed in an EA.

The Queensland Waterways and Waterway Barrier Works mapping (DAF 2016) assists in the determination of whether a site of proposed waterway barrier works requires assessment and approval under the Fisheries Act. It maps waterways from a low to major risk of impact on fish movement. Major risk is generally associated with larger waterways, higher quality habitat and bigger populations of fish (DAF 2013). Any impacts to watercourses

and fish passage will be assessed and approved through the EA and associated environmental impact assessment process.

2.6 Biosecurity Act 2014

The Queensland *Biosecurity Act 2014* (Biosecurity Act) provides biosecurity measures to safeguard Queensland's economy, agricultural and tourism industries, environment, and way of life, from pests, disease, and contaminants.

All persons have a 'general biosecurity obligation' under the Biosecurity Act. This means that everyone is responsible for managing biosecurity risks that are under their control and that they know about or should reasonably be expected to know about. Under the 'general biosecurity obligation', individuals and organisations whose activities pose a biosecurity risk must:

- take all reasonable and practical steps to prevent or minimise each biosecurity risk
- minimise the likelihood of causing a biosecurity event, and limit the consequences if such an event is caused
- prevent or minimise the harmful effects a risk could have, and not do anything that might make any harmful effects worse.

2.6.1 Prohibited matter

Prohibited matter is listed in Schedule 1 of the Biosecurity Act and refers to biosecurity matter that is not currently found in Queensland but would have a significant adverse impact on our health, way of life, the economy, and the environment if it entered the state.

2.6.2 Restricted matter

Restricted matter is listed in Schedule 2 of the Biosecurity Act and refers to biosecurity matter (including invasive plants) that are currently found in Queensland and that are known to have a significant impact on human health, social amenity, the economy, or the environment. Specific actions are required to limit the spread and impact of this matter by reducing, controlling, or containing it.

Restricted aquatic matter in the study area includes the pest fish species mosquitofish (*Gambusia holbrooki*) (Section 5.5.1).

2.7 Environmental Offsets Act 2014 (EO Act)

The environmental offsets framework in Queensland includes the *Environmental Offsets Act 2014*, the *Environmental Offsets Regulation 2014* (EO Regulation) and the Queensland Environmental Offsets Policy (QEOP). The EO Act coordinates the delivery of environmental offsets across jurisdictions and provides a single, coordinated approach to offsets in Queensland. The EO Regulation provides details of the prescribed activities regulated under existing legislation and prescribed environmental matters to which the Act applies. The QEOP provides a consistent, whole-of-government policy for the assessment of offset proposals to satisfy offset conditions.

Matters of State Environmental Significance (MSES) are defined in the EO Regulation and are a component of the biodiversity state interest identified in the Queensland State Planning Policy. Significant, residual impacts to MSES will require provision of environmental offsets.

MSES relevant to aquatic ecology include:

- Wetlands and watercourses, including:

- a High Ecological Significance (HES) wetland in a Wetland Protection Area (WPA) shown on the Map of Great Barrier Reef Wetland Protection Areas
- a wetland or watercourse in High Ecological Value Waters

- Highly protected zones of State marine parks
- Fish Habitat Areas
- A waterway providing for fish passage, if the construction, installation, or modification of waterway barrier works would limit the passage of fish along the waterway
- Marine plants, if outside of an urban area.

Other MSES which may have an association with aquatic values include:

- Regulated Vegetation, including:
  - Endangered and Of Concern REs
  - a RE that intersects with an area shown as a wetland on the Vegetation Management Wetlands Map
  - an area of essential habitat on the Essential Habitat Map for Endangered or Vulnerable flora or fauna
  - an area located within a defined distance (identified in the QEOP) from the defining banks of a relevant watercourse.
- Protected wildlife habitat, including:
  - High Risk Areas (HRAs) identified on the flora survey trigger map and that contain Endangered or Vulnerable flora
  - areas not shown as a HRA on the flora survey trigger map, to the extent the area contains Endangered or Vulnerable flora
  - habitat for Endangered, Vulnerable or SLC fauna
- Protected areas
- Legally secured offset areas.

An environmental offset may be required as a condition of approval where – following consideration of avoidance and mitigation measures – the activity is likely to result in a significant residual impact on a MSES. To determine if a residual impact from a prescribed activity is significant, the Significant Residual Impact Guideline (DSDIP 2014) is used for consideration of applications made under the EP Act, NC Act and *Marine Parks Act 2004*.

Where required, the QEOP allows for environmental offsets to be delivered as:

- financial settlement offsets
- proponent-driven offsets – including land-based offsets and / or delivery of actions in Direct Benefit Management Plans
- a combination of both.

This baseline aquatic ecology survey report identifies those aquatic related MSES within the study area.

3 Existing environment

3.1 Climate and weather

Blackwater is located in the Central Highlands Region of Queensland. The region's climate is sub-tropical, sub-humid with nearly half its annual rainfall occurring in summer. In the three months preceding the December 2019 surveys, Blackwater Airport weather station (station 035134) recorded 0.0 millimetres (mm) of rainfall in September, 8.2 mm in October and 1.4 mm in November (BOM 2020). Substantial rainfall (270.2 mm) was recorded in January to February 2020 (BOM 2020). This included intense rainfall, runoff, and consequent flooding at each riverine site, as evidenced by flood debris (Appendix C). Only 0.4 mm was recorded at Blackwater Airport in the three months preceding the May 2020 surveys (BOM 2020), leading to dry conditions at most riverine sites at the time of assessment in May 2020 (Appendix C).

Mean minimum and maximum temperatures for December 2019 at Blackwater Airport were 21.9°C and 38.2°C, respectively (BOM 2020). Mean minimum and maximum temperatures for May 2020 at Blackwater Airport were 12.3°C and 25.0°C, respectively (BOM 2020).

3.2 Topography

The topography of the study area is gently undulating and low-lying (less than 300 m Australian Height Datum [mAHD]). Elevation ranges from about 235 mAHD near tributaries of Two Mile Gully to about 170 mAHD in the downstream-most reach of Sagittarius Creek.

3.3 Catchments

The study area lies within the Fitzroy Basin and within the Mackenzie River sub-basin. Within the study area, Two Mile Gully and Deep Creek flow into Taurus Creek, which flows into Blackwater Creek, flowing north and passing to the east of Blackwater (Figure 1.1). Sagittarius Creek flows north and passes to the west of Blackwater, meeting Blackwater Creek to the north of Blackwater, then into the Mackenzie River.

At a regional scale, the Mackenzie River sub-basin is approximately 12,985 square kilometres (km²) and the broader Fitzroy River basin is approximately 142,545 km² (DES 2020a).

The document titled *Environmental Protection (Water) Policy 2009: Mackenzie River Sub-basin Environmental Values and Water Quality Objectives Basin No. 130 (part), including all waters of the Mackenzie River Sub-basin* (DEHP 2011a) and accompanying maps have been considered as they identify environmental values (EVs) for the study area. The relevant EVs, being for the Mackenzie southern tributaries, are:

- aquatic ecosystems
- farm supply/use
- stock water
- human consumption
- primary, secondary and visual recreation
- drinking water
- industrial use
- cultural and spiritual values.

3.4 Land zones and soils

The following land zones occur within the study area.

- Land zone 3 - Recent Quaternary alluvial systems, including closed depressions, paleo-estuarine deposits currently under freshwater influence, inland lakes and associated wave-built lunettes. Excludes colluvial deposits such as talus slopes and pediments. Includes a diverse range of soils, predominantly Vertosols and Sodosols; also, with Dermosols, Kurosols, Chromosols, Kandosols, Tenosols, Rudosols and Hydrosols; and Organosols in high rainfall areas.

- Land zone 4 - Tertiary-early Quaternary clay deposits, usually forming level to gently undulating plains not related to recent Quaternary alluvial systems. Excludes clay plains formed in-situ on bedrock. Mainly Vertosols with gilgai microrelief, but includes thin sandy or loamy surfaced Sodosols and Chromosols with the same paleo-clay subsoil deposits.

3.5 Land use

The study area is located in the Bowen Basin, where coal mining is a primary land use. Coal and coal seam gas mining and exploration have been conducted around the study area for decades. Land within the study area is predominantly used for grazing with large areas that have been cleared of native vegetation. Land in the study area is owned by both private landholders and BMA. A number of farm dams (lacustrine waterbody) occur within the study area as shown on Figure 4.1.

4 Methods

4.1 Determination of significance level

CEEVNT species are defined as those taxa listed in the EPBC Act or NC Act as Critically Endangered (CE), Endangered (E), Vulnerable (V) or Near Threatened (NT). Priority species are those listed as such in the Back on Track Actions for Biodiversity for the Fitzroy NRM Region (DERM 2010) or in the Expert Panel Reports of the Aquatic Conservation Assessments (ACA) for riverine and non-riverine wetlands of the Fitzroy section of the Great Barrier Reef (GBR) catchment (Inglis and Howell 2009; Rollason and Howell 2012). All other native fauna species are either Special Least Concern (SLC) or Least Concern (LC) under the NC Act.

4.2 Desktop assessment

Database searches were undertaken prior to field surveys in December 2019 (and revised in 2020 where relevant). This included:

- Department Agriculture, Water and the Environment (DAWE) EPBC Act Protected Matters Search Tool (PMST), to identify aquatic MNES within approximately 20 km of the study area (Appendix A) (DAWE 2020a; Appendix A)
- Department of Environment and Science (DES) (2020a) Wetland *Info* Wetland Summary Information (including species listings) for the Mackenzie River drainage sub-basin and the broader Fitzroy Basin, incorporating data from the DES Wildlife Online database, Queensland Museum and Queensland Herbarium
- DES Queensland Wetland Data Series Version 5 – Queensland Wetlands Map (DES 2020b), to determine the classification, extent, and significance of lacustrine, palustrine, and riverine systems within the study area and surrounds
- DES (2020c) mapping of Matters of State Environmental Significance, to identify aquatic matters of state interest under the State Planning Policy 2017 (SPP)
- Atlas of Living Australia (ALA) (2020), to interrogate existing species records
- Queensland Waterways for Waterway Barrier Works mapping (Queensland Department of Agriculture and Fisheries [DAF] 2016)
- Queensland Groundwater Dependent Ecosystems and Potential Aquifer Mapping 2018 (DES 2020d)
- The Fitzroy Natural Resource Management Region Back-on-Track Actions for Biodiversity (the former Queensland Department of Environment and Mines [DERM] 2010)
- Aquatic Conservation Assessments (ACAs) for the riverine (Inglis and Howell 2009) and non-riverine (Rollason and Howell 2012) wetlands of the Great Barrier Reef catchment
- Published ecological information on EVNT and SLC aquatic flora and fauna species
- Relevant survey guidelines, including the Australian River Assessment System (AusRivAS) protocols for Queensland streams (the former Queensland Department of Natural Resources and Mines [DNRM] 2001).

4.3 Desktop assessment of aquatic groundwater dependent ecosystems

A desktop assessment was completed to identify aquatic ecosystems which potentially utilise and/or are reliant on groundwater in the study area, referred to as groundwater dependent ecosystems (GDEs). This included reviewing:

- the Queensland Groundwater Dependent Ecosystems and Potential Aquifer Mapping 2018 (DES 2020d);
- groundwater monitoring data from BMA bore sites; and
- ground-truthed regional ecosystem mapping.

In Queensland, GDEs are defined as ecosystems which require access to groundwater on a permanent or intermittent basis to meet all or some of their water requirements so as to maintain their communities of plants and animals, ecological processes and ecosystem services (DEHP 2016).

There are three types of GDE classified by Richardson et al. (2011a) being:

1. Type 1 GDE: Aquifer and cave ecosystems (including stygofauna ecosystems) that occur underground. These ecosystems typically include karst aquifer systems, fractured rock and hyporheic zones of rivers, floodplains and coastal environments.

2. Type 2 GDE: Ecosystems dependent on surface expression of groundwater such as wetlands, lakes, springs and river baseflow. In these cases, groundwater extends above earth surface, as a visible expression. These can be obligate or facultative GDEs.

3. Type 3 GDE: Ecosystems dependent on sub-surface presence of groundwater which are terrestrial vegetation using the water table below the natural surface. These communities can fully depend on groundwater or use it on a seasonal or episodic basis to prevent water stress and avoid adverse conditions. These types can exist wherever the water table is within the root zone of the plants either permanently or episodically.

This report assesses only Type 2 (aquatic GDEs). Type 1 and 3 GDEs are assessed in separate reports.

4.4 Field survey

4.4.1 Survey timing, site selection and effort

Aquatic surveys were initially undertaken across the study area between 10 December 2019 to 12 December 2019, aligning with the AusRivAS 'early wet' sampling season (October to December), although conditions were representative of dry season/drought conditions. Follow-up 'late wet' season surveys were undertaken across the study area between 19 May 2020 to 21 May 2020, aligning with the AusRivAS 'late wet' sampling season (May to July).

Desktop investigations, including review of available aerial imagery and review of the Queensland Wetlands Map (DES 2020b), were used to identify representative stream reaches and wetland waterbodies for field assessment. Detailed aquatic survey was attempted at 10 locations, comprising of (Figure 1.1 and Figure 5.5):

- seven riverine system drainage lines based on the Strahler stream order (SO) system (joining of streams of the same order):
  - **Site R3**: one SO 1 site on an un-named tributary
  - **Site R2**: one SO 2 site on Sagittarius Creek

- **Site R1 and Site R5**: two SO 3 sites, including one on Sagittarius Creek (site R1) and one on Taurus Creek (site R5)

- **Sites R6, R4 and R7**: three SO 4 sites, including one on Two Mile Gully (site R6) and two on Taurus Creek (sites R4 and R7).

- three lacustrine wetland waterbodies:

  - **Sites L1 and L2**: two farm dams

  - **Site RW1**: one flood channel wetland (RE 11.3.27b), in May 2020.

A total of 9.4 mm of rainfall was recorded in the three months preceding the December 2019 'early wet' surveys (Section 3.1), with most waterways being dry at the time of assessment. Consequently, habitat assessments were undertaken in place of detailed aquatic surveys at most riverine sites (Table 4.1). Isolated pools were detected and sampled on Taurus Creek (site R4). Two representative lacustrine wetland waterbodies (farm dams) (sites L1 and L2) were also sampled.

Combined rainfall of 270.2 mm was recorded in January and February 2020, with periods of intense rainfall resulting in flooding at each riverine site (Section 3.1, Appendix C). Only 0.4 mm was recorded in the three months preceding the May 2020 'late wet' surveys (Section 3.1), leading to dry conditions at most riverine sites at the time of assessment (Appendix C). Most sites had returned to dry conditions at the time of assessment in May 2020, with isolated pools remaining at site R4 on Taurus Creek.

Lacustrine wetland waterbody sites L1 and L2 were sampled in May 2020, as was the new site RW1 – being a riverine wetland waterbody on a flood channel of Taurus Creek (which was dry at the time of the site visit in December 2019).

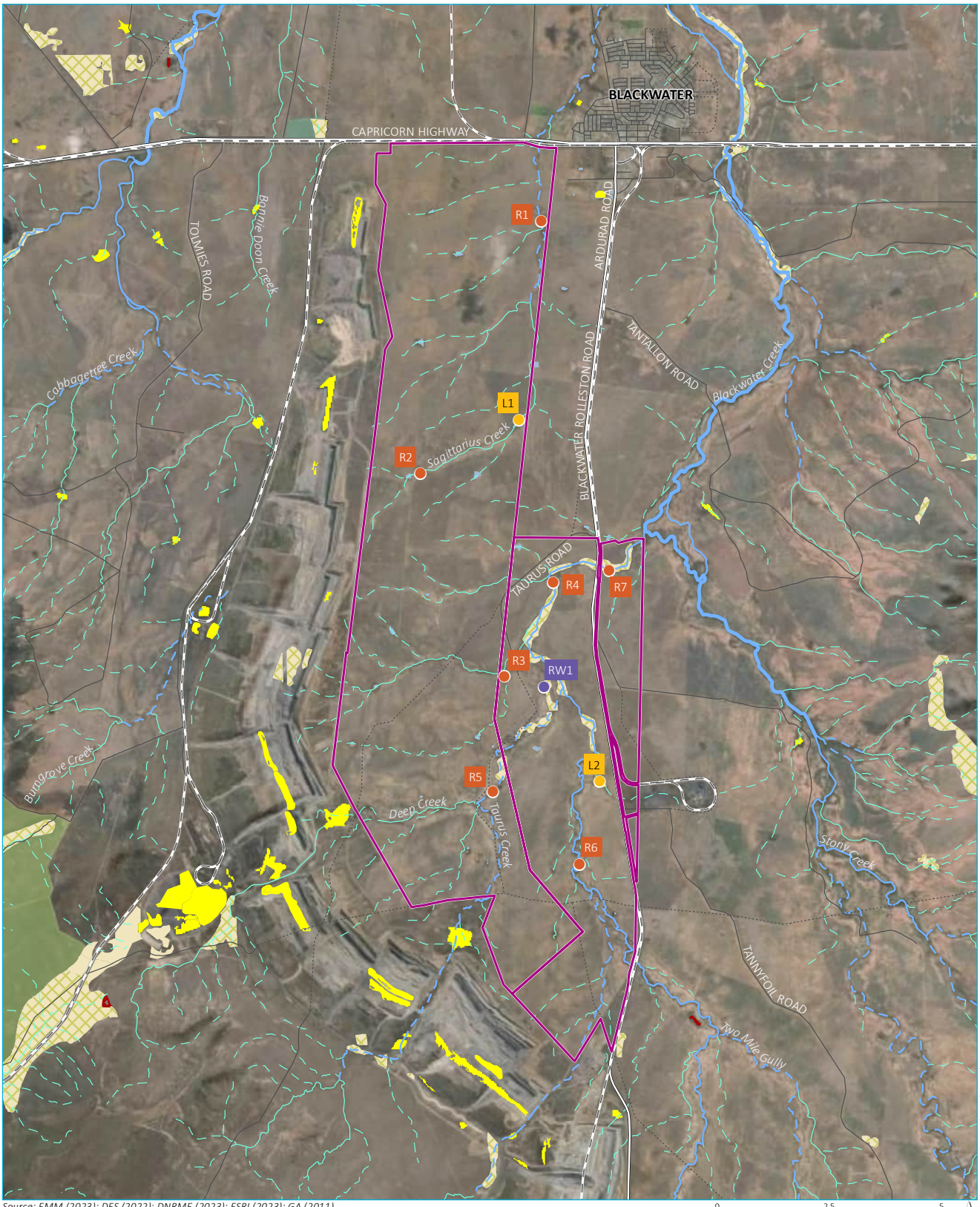
The sampling sites and survey effort conducted in December 2019 are summarised in Table 4.1 and sampling sites and survey effort conducted in May 2020 are summarised in Table 4.2. Survey sites, palustrine waterbodies and lacustrine waterbodies within the study area and surrounds are illustrated in Figure 4.1. It should be noted that several mapped waterbodies shown on Figure 4.1 are artificially created mine waterbodies (e.g., pit lakes or mine dams) to the west of the study area.

Table 4.1 Dry season aquatic survey effort across the study area, December 2019

Site	Site ID	Date / Season	Stream order	Latitude (GDA94)	Longitude (GDA94)	Fish survey effort			Turtle survey effort		Macroinvert. sampling		Physico-chem. water quality	Water sample retained for ion analysis	Habitat assessment/ aquatic plant survey/ photos
						Electro-fishing	Fyke nets	Box traps	Fyke nets	Cathedral traps	Bed habitat	Edge habitat			
Riverine drainage system sites															
Sagittarius Creek	R1	10/12/19	3	-23.6017	148.8635					Dry					✓
Sagittarius Creek	R2	10/12/19	2	-23.6527	148.8377					Dry					✓
Unnamed tributary	R3	11/12/19	1	-23.6933	148.8567					Dry					✓
Taurus Creek	R4	11/12/19	4	-23.6743	148.8671	✓	✓	✓	✓	-	✓	✓	✓	✓	✓
Taurus Creek	R5	12/12/19	3	-23.7165	148.8544					Dry					✓
Two Mile Gully	R6	12/12/19	4	-23.7309	148.8737					Dry					✓
Taurus Creek	R7	12/12/19	4	-23.6717	148.8793					Dry					✓
Lacustrine waterbody sites															
Farm dam	L1	10/12/19	2	-23.6417	148.8591	✓	✓	✓	✓	-		✓	✓	✓	✓
Farm dam	L2	12/12/19	1	-23.7142	148.8777	-	-	-	-	-		-	✓	✓	✓

Table 4.2 Post wet season aquatic survey effort across the study area, May 2020

Site	Site ID	Date / Season	Stream order	Latitude (GDA94)	Longitude (GDA94)	Fish survey effort			Turtle survey effort		Macroinvert. sampling		Physico-chem. water quality	Water sample retained for ion analysis	Habitat assessment/ aquatic plant survey/ photos
						Electro-fishing	Fyke nets	Box traps	Fyke nets	Cathedral traps	Bed habitat	Edge habitat			
Riverine drainage system sites															
Sagittarius Creek	R1	19/05/20	3	-23.6017	148.8635					Dry					✓
Sagittarius Creek	R2	19/05/20	2	-23.6527	148.8377					Dry					✓
Unnamed tributary	R3	21/05/20	1	-23.6933	148.8567					Dry					✓
Taurus Creek	R4	20/05/20	4	-23.6743	148.8671	✓	✓	✓	✓	-	✓	✓	✓	✓	✓
Taurus Creek	R5	21/05/20	3	-23.7165	148.8544					Dry					✓
Two Mile Gully	R6	21/05/20	4	-23.7309	148.8737					Dry					✓
Taurus Creek	R7	20/05/20	4	-23.6717	148.8793					Dry					✓
Riverine wetland waterbody sites															
Taurus Creek flood channel	RW1	21/05/20	3	-23.6954	148.8653	✓	✓	✓	✓	-	✓	✓	✓	✓	✓
Lacustrine wetland waterbody sites															
Farm dam	L1	10/12/19	2	-23.6417	148.8591	✓	✓	✓	✓	-		✓	✓	✓	✓
Farm dam	L2	12/12/19	1	-23.7142	148.8777	-	-	-	-	-		-	✓	✓	✓



Source: EMM (2023); DES (2022); DNRME (2023); ESRI (2023); GA (2011)

0 2.5 5 km

GDA2020 MGA Zone 55

N

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KEY

- Study area

Queensland wetland mapping (v4)

- Lacustrine Waterbodies
- Palustrine Waterbodies
- Palustrine RE
- RE 51-80% wetland (mosaic units)
- RE 1-50% wetland (mosaic units)

Aquatic sites surveyed

- Riverine drainage system
- Riverine wetland/waterbody
- Lacustrine waterbody

Stream order

- 1st
- 2nd
- 3rd
- 4th
- 5th

Existing environment

- Rail line
- Major road
- Minor road
- Vehicular track
- Dam/waterbody
- National park/nature reserve
- State forest

Waterways, wetlands and survey locations

BMA - Blackwater Mine
Aquatic Ecology Baseline Assessment
Figure 4.1

EMM creating opportunities

4.4.2 Aquatic habitats

Aquatic habitats were described in accordance with AusRivAS protocols for Queensland streams (DNRM 2001). This established a general description of the environment of each site and its immediate surrounds. The classifications are based on flow level, depth, velocity, width, canopy cover, substrate types, habitat attributes, local catchment erosion, sediment deposits, water colour, algae, water odour, substrate odour, presence of large woody debris, riparian zone width and cover, and general signs of disturbance.

Variable flow, caused by natural events such as rainfall, runoff and drought / flood cycles can influence the aquatic ecosystems of an area. This should be taken into consideration for future studies which may utilise results contained in this report.

Habitat assessment scores (out of 135) were made for each site based on the nine AusRivAS categories (DNRM 2001). Aquatic habitat at each site was classified as Poor, Fair, Good or Excellent based on the overall scores.

A detailed description of the aquatic habitat encountered at each site is included in the site profiles in Appendix C.

4.4.3 Surface water quality

In-situ physico-chemical water quality was assessed as a component of the AusRivAS aquatic habitat assessments, to inform initial equipment settings for backpack electrofishing, and to assist in the interpretation of collected macroinvertebrate data. The ionic composition of surface water was sampled and assessed to assist in characterising surface waters of the study site, including their likely interaction with groundwater.

In-situ measurements

In-situ physico-chemical water quality parameters were measured at each wetted survey site using a YSI Professional Plus multi-parameter water quality meter and Hach Turbidimeter 2100Q, each calibrated both prior to and following sampling. Water quality parameters measured included:

- temperature (°C)
- pH
- electrical conductivity (EC; µS/cm)
- turbidity (NTU)
- dissolved oxygen (mg/L and % saturation).

Ions

Water samples were obtained from each wetted site in accordance with the Monitoring and Sampling Manual: Environmental Protection (Water) Policy (DES 2018). Samples were chilled and delivered to ALS Environmental (a NATA accredited laboratory) and were analysed for the following major ions to assist in characterising surface waters of the study site:

- major anions (Cl, SO_4, F and Alkalinity)
- major cations (Ca, Mg, Na and K) and hardness.

Data analysis

Physico-chemical water quality measurements were compared against Water Quality Objectives (WQOs) nominated in Environmental Protection (Water) Policy 2009: Mackenzie River Sub-basin Environmental Values and Water Quality Objectives Basin No. 130 (part), including all waters of the Mackenzie River Sub-basin (DEHP 2011a). This document includes WQOs for moderately disturbed aquatic ecosystems (applied to riverine sites) and WQOs for lakes/reservoirs (applied to wetland waterbody sites).

4.4.4 Fish

Fish were surveyed at sites R4, RW1 and L1 using a combination of backpack electrofishing, dip-netting, and overnight deployment of baited box traps and fyke nets, dependent on conditions encountered at each site.

Fish survey methods included:

- backpack electrofishing using a Smith-Root LR-24 electrofisher for up to 1,200 seconds power-on time (100 Hz frequency; 20% duty cycle; 150−500 v, to suit conductivity)
- dip-netting in combination with backpack electrofishing, using an Environet® manoeuvred through the water column
- fyke netting – with 2 x fyke nets, dual wing, 4-m wing lengths, 0.6-m drop, 3-mm mesh, baited with beef heart, banana, apple, spinach and rinsed sardines – deployed overnight to capture active fish (and turtles)
- box traps – with 5 x traps, 22 cm x 22 cm x 40 cm, 2-mm mesh, 50-mm opening, baited with dry cat food.

Captured fish were identified, with native species released at the point of capture. Pest fish were euthanised as per DPM Enviroscіences' General Fisheries Permit and Animal Ethics Committee Approval. DPM Enviroscience were subcontracted with EMM to complete aquatic surveys.

4.4.5 Turtles

The Survey Guidelines for Australia's Threatened Reptiles (DSEWPC 2011b) suggest that the Fitzroy River turtle (*Rheodytes leukops*) can be readily observed in riffle zones by diving with a face mask and snorkel, or collected by seine netting, and that the partly carnivorous diet of this species indicates it might be attracted to meat baits in traps. Survey guidelines for the southern snapping turtle (*Elseya albagula*) are not identified by DSEWPC (2011b), due to the subsequent listing of this species as Critically Endangered (from common / Least Concern) in November 2014. However, DPM Enviroscience has successfully captured this species using baited cathedral traps on other projects in the Fitzroy River Basin.

The Terrestrial Vertebrate Fauna Survey Guidelines for Queensland (DSITIA 2014) suggest that freshwater turtle surveys should employ one or more of the following capture techniques:

- visual survey
- snorkelling
- spotlighting
- trapping
- seine netting.

Freshwater turtles were surveyed at sites R4, RW1 and L1 by overnight deployment of baited fyke nets (i.e., trapping), as well as observations of the bank and water surface for sunning and breaching turtles. Suitable habitat for the deployment of cathedral traps (i.e., trees or snags overhanging deep pools) was not encountered.

Snorkelling surveys were noted permitted by BMA safety policy.

4.4.6 Platypus

Habitat suitability for platypus (*Ornithorhynchus anatinus*) was assessed at each site. This included targeted searches for burrows along banks.

4.4.7 Freshwater macroinvertebrates

Freshwater macroinvertebrate samples were collected from suitable habitats in December 2019 (sites R4 and L1) and May 2020 (sites R4, RW1 and L1) to gain an improved understanding of the health, trophic interactions and ecological values of representative aquatic sites. Samples were collected by an AusRivAS accredited ecologist following AusRivAS protocols for Queensland streams (DNRM 2001). AusRivAS protocols specify a standardised, qualitative, rapid bioassessment method that aims to consistently sample a wide diversity of macroinvertebrates within a defined timeframe. The bed and edge habitats were sampled separately at riverine sites R4 and RW1 in accordance with AusRivAS protocols. At farm dam site L1, a composite sample was collected incorporating all macro habitat conditions available (i.e., woody debris, macrophytes, bed and edge habitats).

A standard sized dip net with 250 µm mesh was used to sample macroinvertebrates. Following collection, the samples were transferred to plastic sorting trays, where the contents were sorted and live picked for 30 minutes. Picked specimens were placed into specimen jars with 70% ethanol.

Samples were identified by AusRivAS accredited taxonomists to AusRivAS taxonomic level in the laboratory under stereomicroscope. AusRivAS taxonomic identification is primarily to Family level, with the exception of lower Phyla such as *Porifera*, *Nematoda* and *Nemertea*, *Oligochaetes* (freshwater worms), *Acarina* (mites), and microcrustacea such as *Ostracoda*, *Copepoda* and *Cladocera*. *Chironomids* (midges) are identified to sub-family taxonomic level.

Data analysis

The macroinvertebrate data was used to calculate a number of community descriptors as described in the following sections.

Taxonomic richness

Taxonomic richness was calculated from the number of taxa present in each sample, providing an indication of community diversity at the site, with richness typically increasing with ecological condition.

PET

The Plecoptera, Ephemeroptera and Trichoptera (PET) richness was calculated from the number of taxa belonging to the three PET orders. These three orders are widely accepted as being most sensitive to environmental change, such as habitat degradation and pollution (DEHP 2009). A low PET richness score suggests that a site may be impacted by degradation or pollution, due to the absence of these pollution-sensitive taxa. Conversely, a high PET richness suggests a system free from degradation or pollution.

Pollution-tolerant taxa

The percentage of pollution-tolerant taxa was calculated based on the SIGNAL2 indices. Tolerant taxa are classified as those with a SIGNAL2 score of 3 or less (Marshall et al. 2001). Macroinvertebrate families in this group are expected to be able to tolerate changes to their environment, including habitat degradation and some pollution. An absence of more sensitive taxa suggests environmental conditions may be too harsh for sensitive taxa (those with SIGNAL2 scores above 3) to tolerate.

SIGNAL2

SIGNAL2 (Stream Invertebrate Grade Number – Average Level Version 2) indices were calculated, with each taxon allocated a score from 1 to 10 based on Chessman (2003). Taxa with a low score are most tolerant of a range of environmental conditions, and those with a high score are more sensitive to pollution. The presence / absence data of each taxon were used to calculate the SIGNAL2 average for the site, in accordance with the protocols described by Chessman (2003).

AusRivAS OE50

For riverine sites R4 and RW1, the macroinvertebrate and predictor variables (habitat) data were analysed using the AusRivAS macroinvertebrate predictive modelling program, version 3.2.0 (Ransom and Blackman 2003). The predictive models are typically based on semi-permanent to permanent reference streams. Although the models provide another useful macroinvertebrate community descriptor, the results are applied to ephemeral waterways with caution.

The AusRivAS models utilised, based on location, date and habitats sampled, were the QLD Regional Coastal bed and edge habitat models.

4.4.8 Aquatic flora

Aquatic plants were surveyed at each site. All aquatic plants were identified to species using available literature and taxonomic keys where needed. The abundance of each species was estimated using the AusRivAS categories: extensive (>75% cover), moderate (50−75%), some (10−50%) or little (1−10%).

4.4.9 Overall aquatic values

An aquatic values rating of Low, Moderate or High was assigned to each site based on the summation of all available information from the desktop and field assessments (Table 4.3). When assessing each site, the overall aquatic value criteria that fit the situation best is applied. The criteria in Table 4.3 are listed from most to least important.

Table 4.3 Adopted criteria for assigning aquatic values ratings

Aquatic Values / Sensitivity	Key aquatic values / criteria
High	A site can have one or more of the following to be considered 'high': • semi-permanent or permanent waterbody • mapped as a wetland of High Ecological Significance • confirmed CEEVNT species habitat • confirmed presence of platypus breeding place • near natural/excellent in-stream habitat • excellent habitat bioassessment score (111-135).
Moderate	A site can have one or more of the following to be considered 'moderate': • ephemeral or semi-permanent waterbody • mapped as a wetland of General Ecological Significance • priority aquatic flora species cover moderate or extensive • platypus habitat present • some good quality in-stream habitat • mapped as Major or High risk of impact from fish barriers • good habitat bioassessment score (75-110) • dry season refuge for common (Least Concern) species.
Low	A site can have one or more of the following to be considered 'low': • ephemeral waterbody • no CEEVNT species or platypus habitat present • in-stream habitat highly modified / disturbed • poor to fair habitat bioassessment score (0-74).

5 Results

5.1 Waterways

The Queensland Wetlands Map 2015 (DES 2020b) identifies riverine systems, watercourses, waterways, or drainage lines (here referred to collectively as waterways) for the study area.

As shown in Figure 4.1 the study area predominantly includes minor ephemeral waterways classified as SO1 and SO2. In the eastern and southern portions of the study area are sections of SO3 and SO4 associated with Taurus Creek, Sagittarius Creek and Two Mile Gully which becomes Taurus Creek. Taurus Creek then flows north into Blackwater Creek as a SO5.

The DNRME (2020) Watercourse Identification Map (Figure 5.1) identifies Taurus Creek, downstream of its confluence with Two Mile Gully, as a waterway that exhibits the characteristics of a watercourse as defined by the *Water Act 2000*. All other waterways of the study area are yet to be mapped by DNRME (2020) at the time of this assessment.

The Aquatic Biodiversity Assessment and Mapping Method (AquaBAMM) (Clayton et al. 2006), was developed to assess conservation values of wetlands and waterways in Queensland. It is a comprehensive method that uses available data (including data resulting from expert opinion), to identify relative non-social, non-economic conservation/ecological values within a specified study area. The criteria in AquaBAMM are: naturalness (aquatic); naturalness (catchment); diversity and richness; threatened species and ecosystems; Priority species and ecosystems; special features; connectivity and representativeness. The Aquatic Conservation Assessment (ACA) for the riverine (Inglis and Howell 2009) and non-riverine (Rollason and Howell 2012) wetlands of the Great Barrier Reef catchment (produced by the former Queensland Department of Environment and Resource Management [DERM]) is a product of applying this method. The ACA identifies (Figure 5.2):

- Sagittarius Creek and its tributaries as being of medium conservation significance;
- Taurus Creek and its tributaries as being of very low conservation significance; and
- Lacustrine waterbodies (farm dams), where mapped, as being of very low conservation significance.

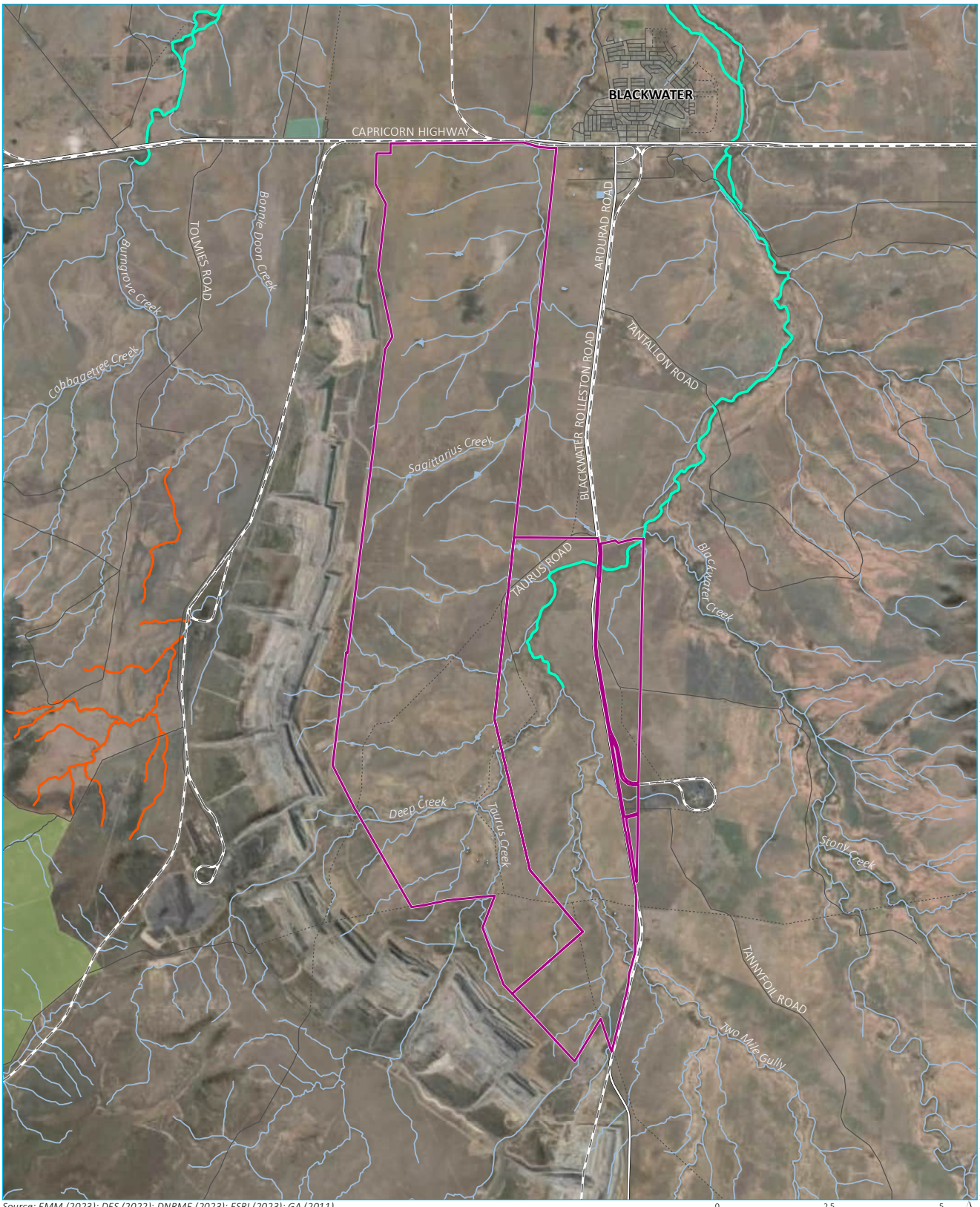
5.1.1 Waterways for fish passage

Fish passage is being considered in this report as it is a MSES value. It is acknowledged having to obtain a waterway barrier works permit is not required where the works occur in a ML under an EA.

The DAF (2016) Queensland Waterways for Waterway Barrier Works 2016 mapping (Figure 5.3) indicates the level of 'risk' associated with undertaking waterway barrier works within Queensland waterways. Waterways with higher stream orders, steeper slopes, higher flow rates, greater numbers of fish present and fish with stronger swimming abilities are allocated a higher level of risk (DAFF 2013).

In consideration of these factors, Two Mile Gully and Taurus Creek are mapped as being of high and major risk of adverse impact from waterway barrier works on fish movement (DAF 2016). Sections of Sagittarius Creek are mapped as being of moderate and high risk of adverse impact, and other mapped waterways within the study area are indicated as being of low to moderate risk of adverse impact from waterway barrier works on fish movement (DAF 2020) (Figure 5.3).

In summary the waterways with potential for greater impact on fish passage are in the eastern and southern sections of the study area along the larger stream orders as shown in Figure 5.3.



Source: EMM (2023); DES (2022); DNRME (2023); ESRI (2023); GA (2011)

0 2.5 5 km

GDA2020 MGA Zone 55

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KEY

- Study area

Watercourse identification map (DNRME 2019)

- Watercourse (defined by Water Act 2000)
- Drainage feature (defined by Water Act 2000)
- Yet to be mapped

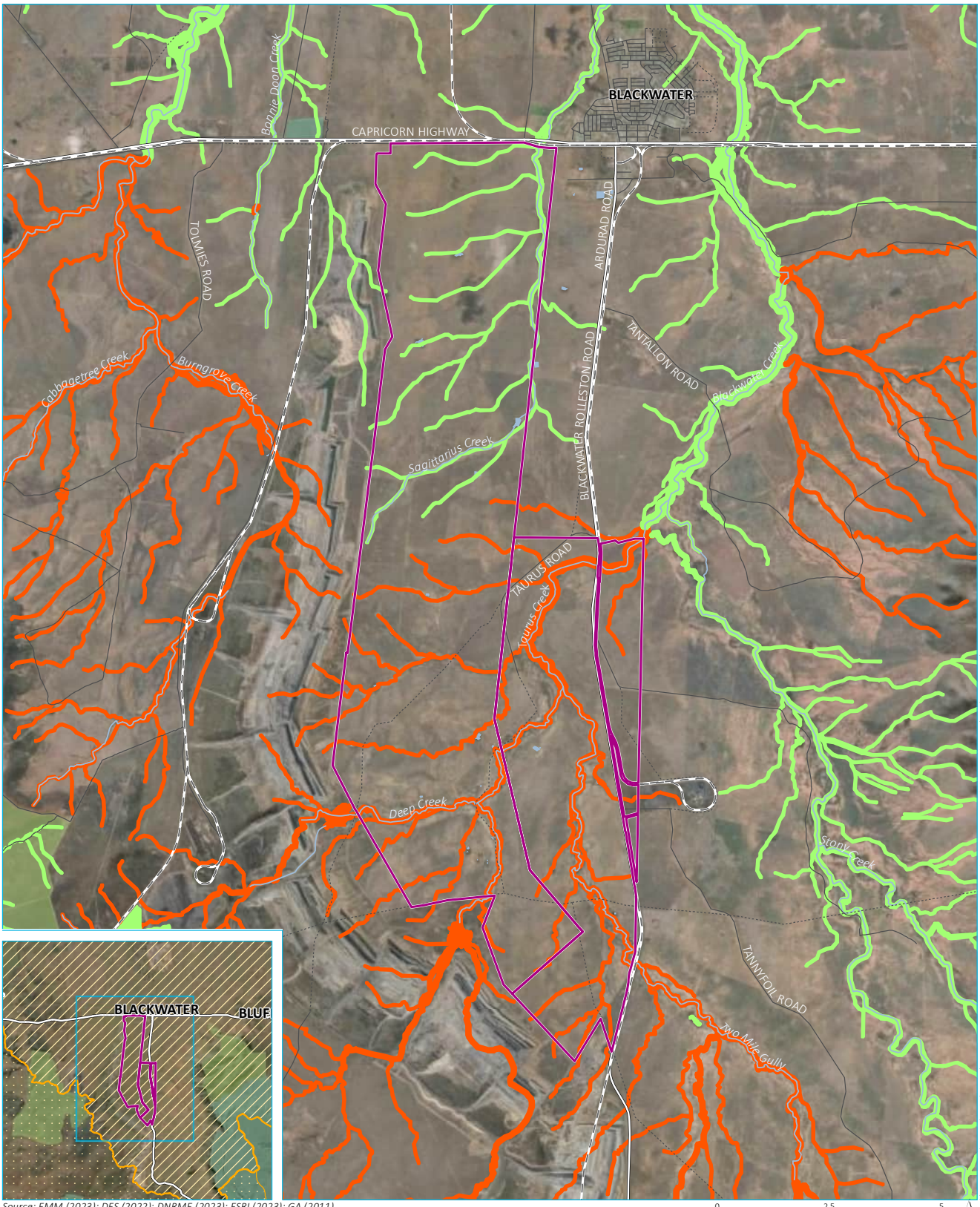
Existing environment

- Rail line
- Major road
- Minor road
- Vehicular track
- Dam/waterbody
- National park/nature reserve
- State forest

Watercourses under the Water Act 2000

BMA - Blackwater Mine
Aquatic Ecology Baseline Assessment
Figure 5.1

EMM creating opportunities



Source: EMM (2023); DES (2022); DNRME (2023); ESRI (2023); GA (2011)

0 2.5 5 km

GDA2020 MGA Zone 55

N

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KEY

Study area

Aquatic conservation significance

- Medium
- Very Low

Great Barrier Reef - aquatic conservation assessment study area (refer inset)

- Comet
- Mackenzie

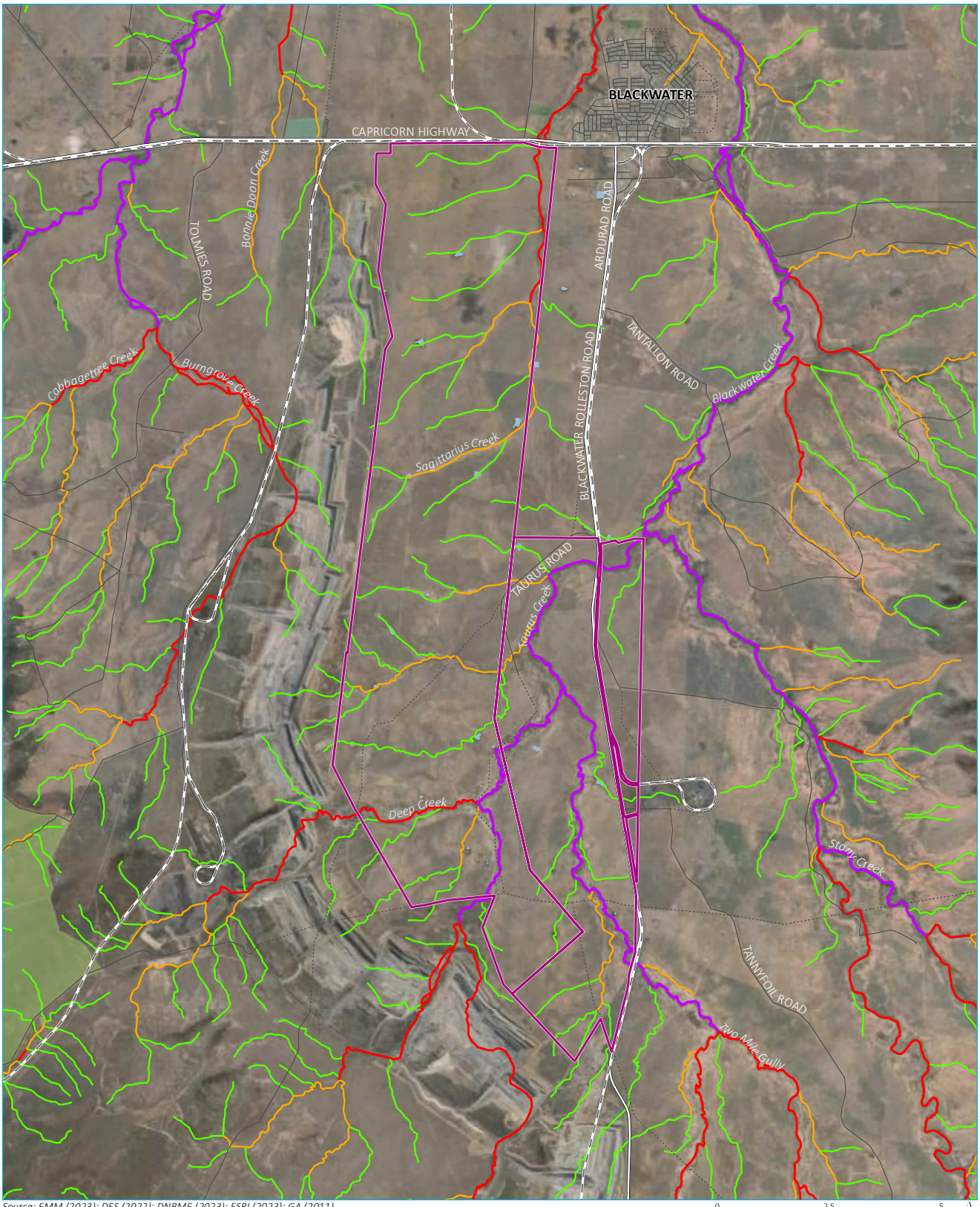
Existing environment

- Rail line
- Major road
- Minor road
- Vehicular track
- Dam/waterbody
- National park/nature reserve
- State forest

Great Barrier Reef - aquatic conservation assessment areas

BMA - Blackwater Mine
Aquatic Ecology Baseline Assessment
Figure 5.2

EMM creating opportunities



Source: EMM (2023); DES (2022); DNRME (2023); ESRI (2023); GA (2011)

0 2.5 5 km

GDA2020 MGA Zone 55

N

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KEY

Study area

Fish passage

Risk of impact

- Major
- High
- Moderate
- Low

Existing environment

- Rail line
- Major road
- Minor road
- Vehicular track
- Dam/waterbody
- National park/nature reserve
- State forest

Fish passage

BMA - Blackwater Mine
Aquatic Ecology Baseline Assessment
Figure 5.3

EMM creating opportunities

5.2 Aquatic habitat

5.2.1 Waterways

The waterways of the study area are ephemeral and experience flow only after sustained or intense rainfall and runoff in the catchment. Stream flows are expected to be highly variable, with most channels expected to dry during winter to early spring when rainfall and runoff is historically low. Consequently, physical attributes, water quality, and the composition of aquatic flora and fauna communities are expected to be highly variable over time.

5.2.2 Surface water quality

Physico—chemical water quality

Surface water temperatures at the time of assessment in December 2019 ranged from 26.7°C (warm) to 35.6°C (hot), and in May 2020 ranged from 19.0 to 20.0 (cool) (Table 5.1). Water temperatures are influenced by season, time of day, shading / exposure, and waterbody depth.

pH levels in December 2019 were mildly alkaline (7.9) at riverine site R4 and moderately alkaline (8.1) to strongly alkaline (8.6) at the lacustrine wetland waterbody (farm dam) sites L1 and L2, respectively (Table 5.1). pH levels in May 2020 were mildly alkaline (7.6) at riverine site R4 and ranged from mildly alkaline (7.8) to strongly alkaline (8.6) at the lacustrine wetlands waterbody sites (L1, L2 and RW1). The higher pH levels likely reflect the clay rich soils of the catchment as well as the high contact time with silt/clay substrates in these waterbodies.

With the exception of site L2, each wetted site exhibited 'fresh' (<800 µS/cm) water, with similar electrical conductivity (EC) levels across the riverine and lacustrine waterbody sites (Table 5.1). EC levels in riverine site R4 exceeded the conservative WQO guidelines of 310 µS/cm (Mackenzie River drainage sub-basin) in both sampling events. EC levels in the lacustrine waterbody wetland sites ranged from 414 µS/cm at site L1 in May 2020 to 2,401 µS/cm (brackish) at site L2 in May 2020.

Surface water dissolved oxygen (DO) levels were highly variable across the study area, reflecting time of day, temperature, organic load, biological activity and rate of transfer from the atmosphere. DO measurements ranged from 20.3% saturation (low) at site R4 in May 2020 to 89.0% at site RW1 in May 2020 (Table 5.1). The low DO levels reflect a number of factors, including time of day and likely oxygen consumption by aerobic bacteria during the breakdown of organic matter in these isolated and drying waterbodies.

Turbidity measurements at site R4 ranged from 24 to 40 NTU (high to moderate clarity) (Table 5.1). Turbidity levels in the lacustrine wetland waterbody sites ranged from 23.5 NTU (high clarity) at site L2 in May 2020 to 41 NTU (moderate clarity) at site L1 in May 2020. The higher clarity at site L2 likely reflects the brackish conditions (sediments flocced by salts).

Water hardness ranged from 95 mg/L (moderate) at L1 in December 2019 to 634 mg/L (extremely hard) at site L2 in May 2020. The hard water at most sites is likely due to the high contact time with the substrates.

Table 5.1 Surface water quality measurements, December 2019 and May 2020

Parameter		Units	WQO		Riverine		Lacustrine	
			R4 [R-M]	R4 [R-M]	RW1	L1	L1	L2	L2
Date	DD/MM/YY	-	11/12/19	20/05/20	21/05/20	10/12/19	19/05/20	12/12/19	21/05/20
Time	HH:MM	-	12:00	10:30	13:45	11:30	12:00	10:20	12:10
Physico-chemical water quality									
Temperature	˚C	-	26.7	19.0	20.0	26.9	19.1	30.1	19.7
pH	pH units	6.5[R-M], 6.5-8.0[L]	7.9	7.6	**8.6**	**8.6**	7.8	**8.1**	7.9
Electrical	µS/cm	<310 [R-M, B],	**387**	**676**	**573**	**437**	**414**	**595**	**2,401**
DO	% saturation	85 [R-M], 90-110 [L]	**36.0**	**20.3**	**89.0**	**76.0**	**75.1**	**87.9**	**66.0**
	mg/L	-	2.9	1.9	8.1	5.7	6.9	6.6	5.98
Turbidity	NTU	<50 [R-M], 1-20[L]	24	40	**27**	**40**	**41**	**31**	**23.5**
Hardness (as	mg/L	-	133	193	117	95	134	187	634
Alkalinity (as	mg/L	-	136	282	123	176	194	206	298
Major cations									
Calcium (Ca^{2+})	mg/L	-	32	51	27	20	34	42	132
Magnesium	mg/L	-	13	16	12	11	12	20	74
Sodium (Na^{+})	mg/L	-	27	68	67	65	34	59	286
Potassium (K^{+})	mg/L	-	7	8	7	6	7	13	16

Table 5.1 Surface water quality measurements, December 2019 and May 2020

Parameter		Units	WQO		Riverine		Lacustrine	
			R4 [R-M]	R4 [R-M]	RW1	L1	L1	L2	L2
Major anions									
Chloride (Cl^-)	mg/L	-	40	51	68	36	23	60	248
Sulphate (SO_4^{2-})	mg/L	<10[R-M]	3	14	62	<1	<1	**16**	**643**
Fluoride (F^-)	mg/L	-	0.2	0.4	0.4	0.9	0.5	0.4	0.3
Carbonate (CO_3^-)	mg$CaCO_3$/L	-	<1	<1	<1	16	<1	6	<1
Bicarbonate	mg$CaCO_3$/L	-	136	282	123	160	194	200	298

Notes:
[R-M] Applies to riverine sites of the Mackenzie River drainage sub-basin; [B] Applies to baseflow conditions (as opposed to high flow conditions); [L] Applies to freshwater lakes / reservoirs
Bold text indicates exceedance of the relevant WQO.

Ions

The concentration and proportion of ions in surface waters depends on the location of the waterway (geology, land-use and topography), climate, the proportionate contributions of groundwater flow, interflow and overland flow (Boulton and Brock 1999), and anthropogenic disturbances. These proportionate contributions will vary depending on seasonal and climatic patterns and so the source of ions will also vary. In low to no flow conditions, groundwater sources and/or evaporative processes typically dominate, and during high flows, catchment and atmospheric sources typically dominate.

The concentration of major anions and cations in surface water samples collected from the study area in December 2019 and May 2020 are presented in Table 5.1 and Appendix B.

Surface water samples generally indicate bicarbonate waters with no dominant cation (Plate 5.1). The dominance of bicarbonate is typical of surface waters. Rainwater accumulates dissolved carbon dioxide from the atmosphere and may pick up more as it trickles over calcareous sediments or organic soil (Boulton and Brock 1999).

The moderate concentration (based on the logarithmic scale of Gibbs [1970]) of total dissolved salts at most sites (approximately 263 to 460 mg/L, inferred from EC levels of 387 to 676 µS/cm) in these bicarbonate dominated waters suggests that catchment soils or geology are the main source of dissolved material; i.e. the dissolution of soil/rock is the major process controlling surface water chemistry, rather than atmospheric precipitation or evaporation/crystallization. Elevated levels of sulphate, sodium and chloride were found at site L2.

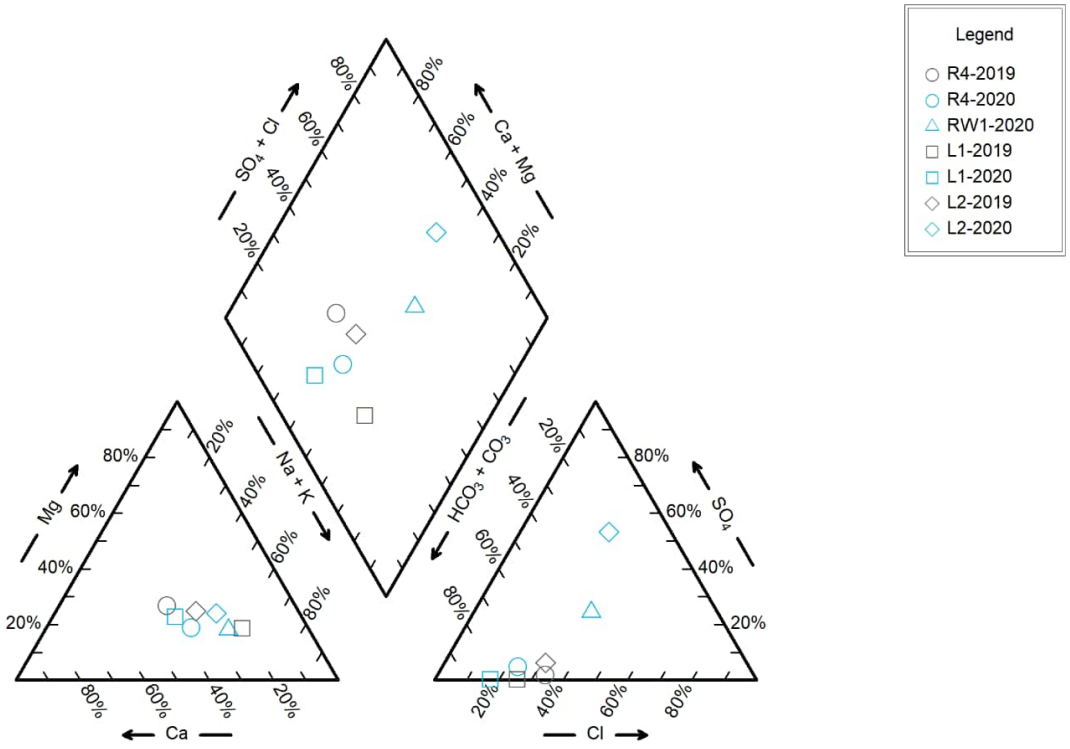


Plate 5.1 Relative abundance of major cations and anions from surface water samples collected from the study area, December 2019 and May 2020

5.2.3 Instream habitat

Instream (aquatic) habitat assessment scores ranged from poor to fair for the riverine survey sites across the study area, with most sites scoring fair (Table 5.2 and Table 5.3Table 5.2). Bottom substrate/available cover and embeddedness was mostly rated poor or fair, owing to the dominance of fine sediments (silt/clay and sand) and general lack of the larger pebble, cobble, and boulder substrates at each site. However, most sites exhibited at

least some detritus, sticks, branches, and logs, providing some instream habitat and refugia for aquatic fauna. Velocity/depth category rated poor at each site due to lack of water or flow. Streamside cover rated excellent at most sites, reflecting riparian vegetation dominated by trees.

Table 5.2 Aquatic habitat assessment scores for riverine survey sites across the study area, December 2019

Habitat variable	R1	R2	R3	R4	R5	R6	R7
Bottom substrate/available cover	P (3)	F (6)	P (1)	P (5)	P (2)	F (7)	G (11)
Embeddedness	P (3)	F (6)	P (5)	P (5)	P (2)	F (8)	F (8)
Velocity/depth category	P (0)	P (0)	P (0)	P (2)	P (0)	P (0)	P (0)
Channel alteration	E (12)	F (5)	P (2)	G (11)	F (6)	G (8)	E (12)
Bottom scouring and deposition	E (12)	G (11)	P (3)	G (10)	F (6)	F (7)	E (12)
Pool/riffle, run/bend ratio	F (4)	F (4)	F (4)	F (5)	F (5)	F (6)	F (6)
Bank stability	F (5)	F (5)	P (1)	F (5)	F (4)	F (5)	G (6)
Bank vegetative stability	G (6)	F (5)	F (4)	G (7)	F (3)	F (3)	F (5)
Streamside cover	E (9)	E (9)	E (9)	E (9)	E (9)	E (9)	E (10)
Total (out of 135)	**54**	**51**	**29**	**59**	**37**	**53**	**70**
Rating	**Fair**	**Fair**	**Poor**	**Fair**	**Poor**	**Fair**	**Fair**

Notes: AusRivAS habitat assessment scoring and categories consistent with DNRM (2001).
Legend Green: Excellent (E), Yellow: Good (G), Orange: Fair (F), Pink: Poor (P)

Table 5.3 Aquatic habitat assessment scores for riverine survey sites across the study area, May 2020

Habitat variable	R1	R2	R3	R4	R5	R6	R7	RW1
Bottom substrate/available cover	P (3)	F (6)	P (1)	P (5)	P (2)	F (7)	G (11)	P (5)
Embeddedness	P (3)	F (6)	P (5)	P (5)	P (2)	F (8)	F (8)	P (5)
Velocity/depth category	P (0)	P (0)	P (0)	P (2)	P (0)	P (0)	P (0)	P (5)
Channel alteration	E (12)	F (5)	P (2)	G (11)	F (6)	G (8)	E (12)	G (11)
Bottom scouring and deposition	E (12)	G (11)	P (3)	G (10)	F (6)	F (7)	E (12)	F (6)
Pool/riffle, run/bend ratio	F (4)	F (4)	F (4)	F (5)	F (5)	F (6)	F (6)	P (5)
Bank stability	F (5)	F (5)	P (1)	F (5)	F (4)	F (5)	G (6)	G (6)

Table 5.3 Aquatic habitat assessment scores for riverine survey sites across the study area, May 2020

Habitat variable	R1	R2	R3	R4	R5	R6	R7	RW1
Bank vegetative stability	G (6)	G (6)	F (4)	G (7)	F (5)	F (3)	F (5)	F (5)
Streamside cover	E (9)	E (9)	E (9)	E (9)	E (9)	E (9)	E (10)	E (9)
Total (out of 135)	**54**	**52**	**29**	**59**	**39**	**53**	**70**	**57**
Rating	**Fair**	**Fair**	**Poor**	**Fair**	**Poor**	**Fair**	**Fair**	**Fair**

Notes: AusRivAS habitat assessment scoring and categories consistent with DNRM (2001).
Legend Green: Excellent (E), Yellow: Good (G), Orange: Fair (F), Pink: Poor (P)

5.2.4 Bank stability/erosion

Bank stability ranged from poor (unstable) at site R3 to good (moderately stable) at site R7. Bank stability rated fair (moderately unstable) at all other riverine sites, where the moderate frequency and size of erosional areas and/or bank slopes of up to 60% suggests high erosion potential during a high flow event. However, bank vegetative stability rated fair to good at most riverine sites, indicating that at least 50% of the stream bank surfaces were covered by vegetation at the time of assessment. Bank vegetative stability improved slightly at some sites from December 2019 to May 2020.

5.2.5 Adjacent land use

Land use across the study area is dominated by cattle grazing of varying intensity. Riparian zone widths were approximately 20 m (single bank measurements) at site R5 (Taurus Creek) (Appendix C). Trees commonly encountered in riparian zones across the study area included yellowwood (*Terminalia oblongata*), brigalow (*Acacia harpophylla*), coolabah (*Eucalyptus coolabah*), forest red gum (*E. tereticornis*), silver-leaved ironbark (*E. melanophloia*), poplar box (*E. populnea*), red bauhinia (*Lysiphyllum carronii*) and narrow-leaved bottletree (*Brachychiton rupestris*). The shrub layer and groundcover was variable across the site (Appendix C).

5.2.6 Aquatic values

Aquatic values for each site are presented in the site profiles in Appendix C. Ratings for aquatic values were determined for each site based on the criteria in Section 4.4.9 and are presented in Table 5.4. There was no change in aquatic values ratings between December 2019 and May 2020.

Riverine sites on Sagittarius and Taurus Creeks and Two Mile Gully were rated as having moderate aquatic values due largely to their importance as conduits for fish passage and being classified as high or major risk of impact on fish passage. Riverine sites with a stream order 1−2 were rated as having low aquatic values.

Lacustrine wetland waterbody (farm dam) sites L1 and L2 were rated as having moderate aquatic values, based on being a dry season refuge for Least Concern fish and turtle species.

Table 5.4 Aquatic value ratings for the survey area, December 2019 and May 2020

Site	Waterway	Stream order	Key aquatic values / criteria	Aquatic values rating
R1	Sagittarius Creek	3	• Ephemeral waterway • Fair habitat bioassessment score • No CEEVNT or SLC aquatic species detected • No Priority flora species detected • Important (High risk of impact) conduit for fish passage.	• Moderate
R2	Sagittarius Creek	2	• Ephemeral waterway • Fair habitat bioassessment score • No CEEVNT or SLC aquatic species detected • No Priority flora species detected.	• Low
R3	Unnamed tributary	1	• Ephemeral waterway • Poor habitat bioassessment score • No CEEVNT or SLC aquatic species detected • No Priority flora species detected.	• Low
R4	Taurus Creek	4	• Ephemeral waterway	• Moderate

Table 5.4 Aquatic value ratings for the survey area, December 2019 and May 2020

Site	Waterway	Stream order	Key aquatic values / criteria	Aquatic values rating
			• Accidental dry season refuge for common fish and turtle species (burst pipe nearby) • Fair habitat bioassessment score • No CEEVNT or SLC aquatic species detected • No Priority flora species detected • Important (Major risk of impact) conduit for fish passage.	
R5	Taurus Creek	3	• Ephemeral waterway • Poor habitat bioassessment score • No CEEVNT or SLC aquatic species detected • No Priority flora species detected • Important (Major risk of impact) conduit for fish passage.	• Moderate
R6	Two Mile Gully	4	• Ephemeral waterway • Fair habitat bioassessment score • No CEEVNT or SLC aquatic species detected • No Priority flora species detected • Important (Major risk of impact) conduit for fish passage.	• Moderate
R7	Taurus Creek	4	• Ephemeral waterway • Fair habitat bioassessment score • No CEEVNT or SLC aquatic species detected • Little cover of Priority flora species • Important (Major risk of impact) conduit for fish passage.	• Moderate
RW1	Taurus Creek flood channel wetland	3	• Ephemeral wetland waterbody • Fair habitat bioassessment score • No CEEVNT or SLC aquatic species detected • No Priority flora species detected	• Low
L1	Farm dam	2	• Modified (dammed) wetland waterbody • Semi-permanent • No CEEVNT or SLC aquatic species detected • Least concern Eastern snake-necked turtle detected • No Priority flora species detected • Likely dry season refuge for common fish and turtles.	• Moderate
L2	Farm dam	1	• Modified (dammed) wetland waterbody • Semi-permanent • No CEEVNT or SLC aquatic species detected • No Priority flora species detected • Likely dry season refuge for common fish and turtles.	• Moderate

5.3 Wetlands

5.3.1 Wetlands of International Importance

There are no wetlands of International Importance identified within the study area or broader desktop search area in the PMST search (DEE 2020a). Wetlands of International Importance nearest to the study area include those of the Shoalwater and Corio Bays Area, approximately 200 km to the northeast (DEE 2020b).

5.3.2 Wetlands of National Importance

No nationally important wetlands occur in the Mackenzie River drainage sub-basin.

5.3.3 Referrable wetlands

Wetland Protection Areas

The Map of Great Barrier Reef Wetland Protection Areas (DES 2020b) shows the location of Wetland Protection Areas (WPAs), comprising wetlands of HES and their surrounding policy trigger area buffers. These wetlands have been assessed as containing high ecological values by a bioregional aquatic conservation assessment, as per the AquaBAMM (Rollason and Howell 2012).

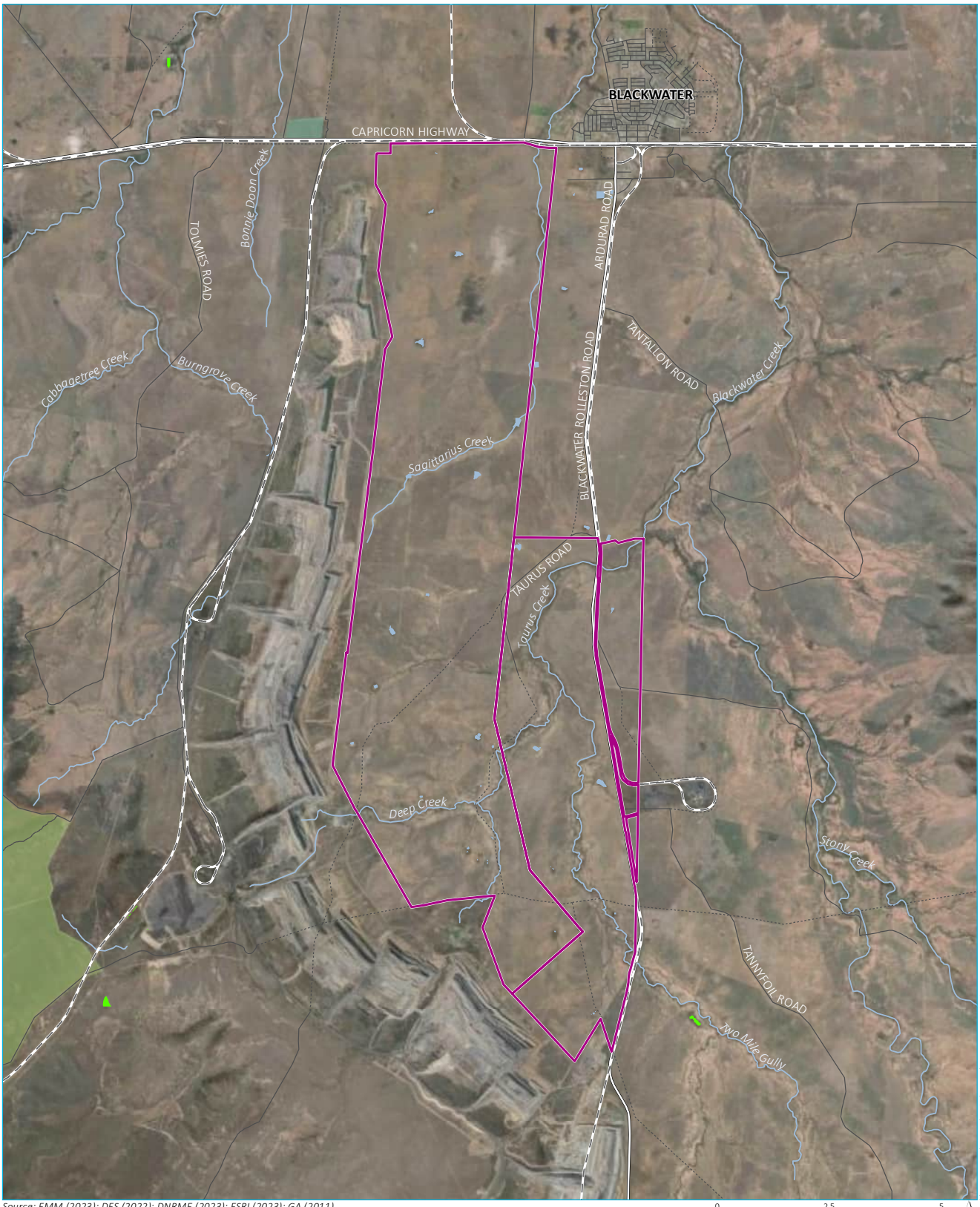
No HES wetlands are mapped as occurring in the study area or surrounds (Figure 5.4).

Queensland Wetland Environmental Values

The Map of Queensland Wetland Environmental Values (MQWEV) identifies the location and ecological significance of wetlands using the environmental values for wetlands in section 7 of the *Environmental Protection (Wetland and Water Biodiversity) Policy 2019* (EPP 2019). Wetlands are considered either HES or of General Ecological Significance (GES) for the purposes of allocating environmental values. The MQWEV also shows High Ecological Value (HEV) waters management intent under Schedule 2 of the EPP 2019.

No State-mapped GES wetlands are mapped as occurring in the study area. One GES wetland is mapped upstream of the study area on Two Mile Gully (Figure 5.4).

No HEV waters are identified for the study area or surrounds in the MQWEV.



Source: EMM (2023); DES (2022); DNRME (2023); ESRI (2023); GA (2011)

0 2.5 5 km

GDA2020 MGA Zone 55

N

\\emmsvr1\EMM\Jobs\2018\B180329 - Blackwater Mine - Environmental Monitoring and data gathering\GIS\02_Maps\AquaticSurveyReport\NorthernStudyArea\AQE006_QLDwetlandEnvironmentalValues_20230713_10.mxd 13/07/2023

KEY

Study area

Wetland environmental values

Wetland of general ecological significance

Existing environment

Rail line

Major road

Minor road

Vehicular track

Dam/waterbody

National park/nature reserve

State forest

Queensland wetland environmental values

BMA - Blackwater Mine
Aquatic Ecology Baseline Assessment
Figure 5.4

EMM creating opportunities

5.4 Aquatic flora

Fourteen species of aquatic or semi-aquatic flora species were recorded from the study area during the December 2019 surveys (Table 5.5). An additional seven aquatic or semi-aquatic flora species were recorded from the study area during the May 2020 surveys (Table 5.6).

All aquatic flora species detected are considered Least Concern under the NC Act. Three priority aquatic flora species were detected:

- Tall flatsedge (*Cyperus exaltatus*);
- Water snowflake (*Nymphoides indica*); and
- Swamp lily (*Ottelia alismoides*).

Aquatic flora species encountered consisted predominately of semi-aquatic species including forbs, grasses, rushes, and sedges.

The lack of both diversity and abundance of aquatic plants at some sites reflects the harsh physical conditions, cattle grazing and trampling, or a combination of these factors.

Table 5.5 Aquatic flora recorded from the study area, December 2019

Scientific name	Common name	Riverine sites							Lacustrine sites	
		R1	R2	R3	R4	R5	R6	R7	L1	L2
Cyperus sp.	Sedge	L						L		L
Cyperus difformis	Rice sedge									L
Cyperus exaltatus	Tall flatsedge				L					
Cyperus pygmaeus	Dwarf sedge								L	
Juncus usitatus	Common rush									L
Leptochloa digitata	Umbrella canegrass	L			L			L	L	L
Ludwigia octovalvis	Willow primrose								L	
Ludwigia peploides	Water primrose				S					S
Nymphoides indica	Water snowflake									L
Ottelia ovalifolia	Swamp lily								L	
Persicaria attenuata	Smartweed								M	L
Persicaria decipiens	Slender knotweed									L
Potamogeton crispus	Curly pondweed								M	
Typha domingensis	Cumbungi								S	S
Species richness		**2**	**0**	**0**	**3**	**0**	**0**	**2**	**7**	**9**

AusRivAS categories: Little (L), Some (S), Moderate (M), and Extensive (E) consistent with DNRM (2001) methodology.

Table 5.6 Aquatic flora recorded from the study area, May 2020

Scientific name	Common name	Riverine sites							Wetland sites		
		R1	R2	R3	R4	R5	R6	R7	RW1	L1	L2
Cyperus sp.	Sedge										L
Cyperus betchei	-	L			L		L	L		L	
Cyperus concinnus	-							L		L	
Cyperus difformis	Rice sedge	L								L	L
Cyperus exaltatus	Tall flatsedge	L								L	
Cyperus iria	Rice flatsedge				L						
Cyperus pygmaeus	Dwarf sedge	L							L	L	
Diplachne fusca fusca	Brown beetle grass									L	
*Echinochloa colona**	Awnless barnyard grass*	L								L	
*Eclipta prostrata**	White eclipta*	L					L				L
Juncus usitatus	Common rush										L
Leptochloa digitata	Umbrella canegrass	L						L		L	L
Ludwigia octovalvis	Willow primrose									L	L
Ludwigia peploides	Water primrose				L					L	L
Nymphoides indica	Water snowflake										M
Persicaria attenuata	smartweed									L	
Persicaria lapathifolia	Pale knotweed	L								L	
Potamogeton crispus	Curly pondweed									M	

Table 5.6 Aquatic flora recorded from the study area, May 2020

Scientific name	Common name	Riverine sites							Wetland sites	
		R1	R2	R3	R4	R5	R6	R7	RW1	L1	L2
Typha domingensis	Cumbungi									M	S
Species richness		**8**	**0**	**0**	**3**	**0**	**2**	**3**	**1**	**14**	**8**

AusRivAS categories: Little (L), Some (S), Moderate (M), and Extensive (E) consistent with DNRM (2001) methodology.
*Exotic species

5.5 Aquatic fauna

5.5.1 Fish

Nine species were recorded from 741 fishes captured from two locations in the December 2019 surveys (Table 5.6) and seven species were recorded from 2,148 fishes captured from three locations in the May 2020 surveys (Table 5.7). This comprised eight common (Least Concern) native species and one exotic species. Each of the native species had previously been recorded in the Wetland*info* database (DES 2020a) for the Mackenzie River drainage sub-basin. The exotic species, mosquitofish (*Gambusia holbrooki*), was not previously listed in Wetland*info* for the Mackenzie River sub-basin (in which site L1 is positioned).

All native fishes captured appeared healthy, with little sign of stress and no obvious signs of disease. Native fishes were released at the point of capture. Pest fish were humanely euthanised in accordance with DPM Envirosciences' Animal Ethics Committee approval and General Fisheries Permit.

The species composition is typical of ephemeral waterways and farm dams in the region.

Table 5.7 Fish recorded from the study area, December 2019

Scientific name	Common name	Riverine site R4	Lacustrine site L1
Ambassis agassizii	Agassiz's glassfish	39	429
Craterocephalus stercusmuscarum	Flyspecked hardyhead	1	
*Gambusia holbrooki**	Mosquitofish		41
Hypseleotris galii / sp. 1	Firetail / Midgley's gudgeon		42
Hypseleotris klunzingeri	Western carp gudgeon	2	9
Leiopotherapon unicolor	Spangled perch	21	11
Melanotaenia splendida splendida	Eastern rainbowfish	9	4
Mogurnda adspersa	Purple-spotted gudgeon	52	19
Neosilurus hyrtlii	Hyrtyl's tandan		62
Number of individuals		**124**	**617**
Species richness		**6**	**8**

* Exotic species

Table 5.8 Fish recorded from the study area, May 2020

Scientific name	Common name	Riverine site R4	Flood channel wetland site RW1	Lacustrine wetland site L1
Ambassis agassizii	Agassiz's glassfish	156	60	78
*Gambusia holbrooki**	Mosquitofish			529
Hypseleotris galii / sp. 1	Firetail / Midgley's gudgeon	30	256	75

Table 5.8 Fish recorded from the study area, May 2020

Scientific name	Common name	Riverine site R4	Flood channel wetland site RW1	Lacustrine wetland site L1
Leiopotherapon unicolor	Spangled perch	46	28	269
Melanotaenia splendida splendida	Eastern rainbowfish	40	229	111
Mogurnda adspersa	Purple-spotted gudgeon	15	1	59
Nematalosa erebi	Bony bream	36	8	
Neosilurus hyrtlii	Hyrtyl's tandan	10	2	110
Number of individuals		**333**	**584**	**1,231**
Species richness		**7**	**7**	**7**

* Exotic species

5.5.2 Turtles

The Least Concern eastern snake-necked turtle (*Chelodina longicollis*) was recorded at site L1 in December 2019. No CEEVNT turtles were detected within the study area, nor was suitable habitat for CEEVNT turtles encountered (Section 5.6.3).

5.5.3 Platypus

The platypus (*Ornithorhynchus anatinus*) is listed as Special Least Concern (SLC) under the NC Act. The Wetland*Info* database (DES 2020a) identifies the platypus as having previously been recorded from the Mackenzie River drainage sub-basin. The nearest record of platypus is from the Dawson Range State Forest, approximately 30 km east of the survey area (ALA 2020).

No platypus were observed during aquatic surveys, and no survey locations were found to have suitable habitat for the species.

5.5.4 Aquatic Macroinvertebrates

Aquatic macroinvertebrates and stream health

A total of 34 aquatic macroinvertebrate taxa were identified from 499 specimens collected from two sites in December 2019, and 36 aquatic macroinvertebrate taxa were identified from 607 specimens collected from three sites in May 2020. A total of 40 taxa were recorded from the 1,106 specimens collected in December 2019 and May 2020 combined.

Sampling effort for riverine sites was limited by the availability of wetted habitat. The December 2019 sampling consisted of a riverine bed and edge sample from each of sites R4 and RW1, and a composite bed/edge sample from farm dam site L1.

Taxonomic composition

The most taxa-rich order of aquatic macroinvertebrates collected from the study area was *Hemiptera* (true bugs), with ten families identified. *Diptera* (true flies) and *Coleoptera* (beetles) were also well represented, with seven and six families, respectively. Other taxa included *Ephemeroptera* (mayflies), *Trichoptera* (caddis flies), *Zygoptera* (damselflies), *Epiprocta* (dragonflies), *Nematoda* (roundworms), *Oligochaeta* (segmented worms), *Lepidoptera*

(moths [aquatic caterpillars]), *Acarina* (mites), *Decapoda* (yabby, river prawns and glass shrimp); *Gastropoda* (snails); *Cladocera* (water fleas), *Copepoda* (copepods) and *Ostracoda* (seed shrimp).

Taxa richness in the riverine bed habitat samples ranged from 12 taxa (sites R4 in December 2019 and RW1 in May 2020) to 14 taxa at site R4 in May 2020 (Plate 5.2). Taxa richness in the riverine edge habitat samples ranged from 20 taxa at site R4 in May 2020 to 27 taxa at site R4 in December 2019. Composite samples (bed and edge habitats combined) collected from farm dam site L1 ranged from 20 taxa in December 2019 to 26 taxa in May 2020. Data is presented alongside the DEHP WQOs for the Mackenzie River Sub-basin waters (DEHP 2011a). The WQOs apply to riverine systems only. No taxa richness guidelines are available for lakes / reservoirs.

The taxa richness of riverine bed habitat samples fell within the DEHP (2011a) 20:80 percentile guideline range. The taxa richness of riverine edge habitat samples fell within the DEHP (2011a) 20:80 percentile guideline range in December 2019, falling slightly below this range in May 2020.

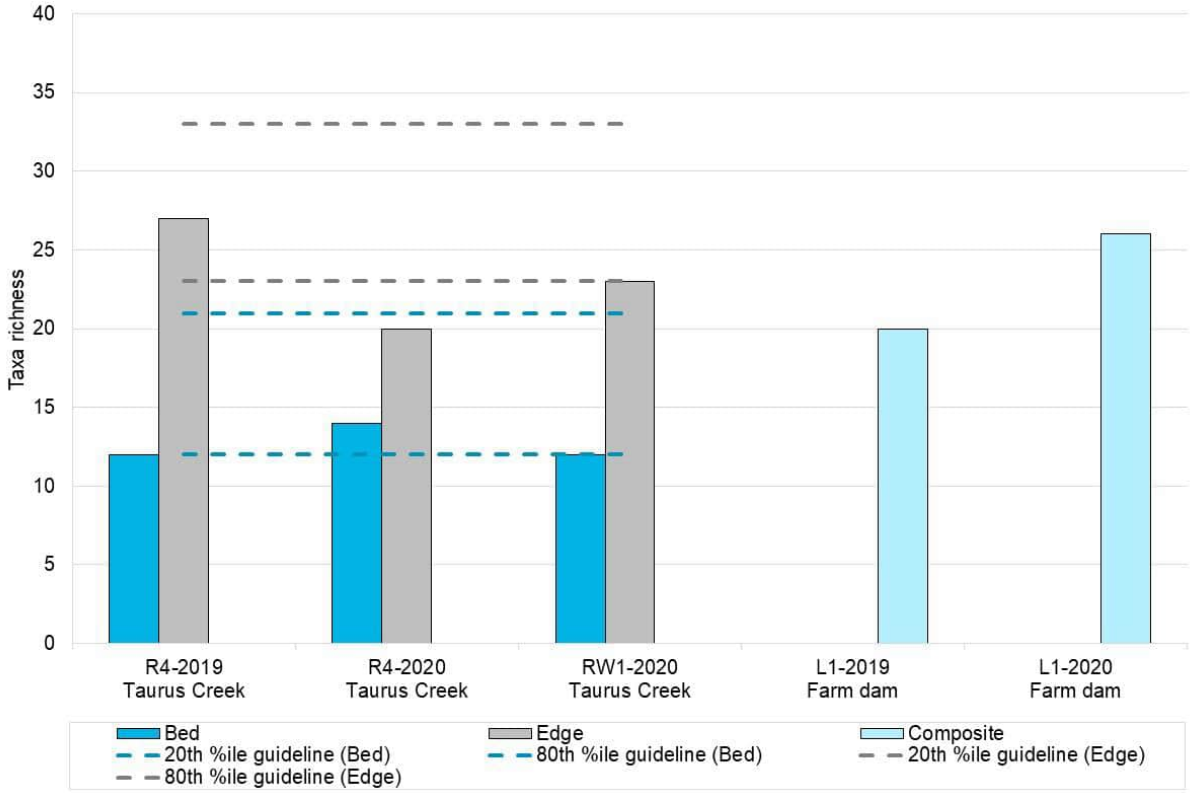


Plate 5.2 Taxa richness of aquatic macroinvertebrate samples collected from the study area, December 2019 and May 2020

PET taxa

Four PET taxa were recorded from the study area, including two *Ephemeroptera* (mayfly) families (*Baetidae* and *Caenidae*) and two *Trichoptera* (caddisfly) families (*Ecnomidae* and *Leptoceridae*). No *Plecoptera* (stoneflies) families were recorded, nor are they expected to occur due to lack of riffle habitat.

Up to one PET taxon was recorded from the riverine bed samples and up to two PET taxa were recorded from the riverine edge samples. All four PET taxa were recorded from farm dam site L1 in December 2019 and May 2020. Data is presented alongside the DEHP (2011a) WQOs for the Mackenzie River Sub-basin waters. The WQOs apply to riverine systems only. As such, no guidelines are presented for the farm dam site.

PET taxa richness in the edge habitat sample collected from site R4 aligned with the DEHP (2011a) 20:80 percentile guideline range in December 2019, indicating an expected number of pollutant sensitive taxa. PET taxa

richness fell below the guideline range in the bed habitat sample from site R4 in December 2019 and in the bed and edge habitat samples from sites R4 and RW1 in May 2020, reflecting poorer habitat complexity (Plate 5.3).

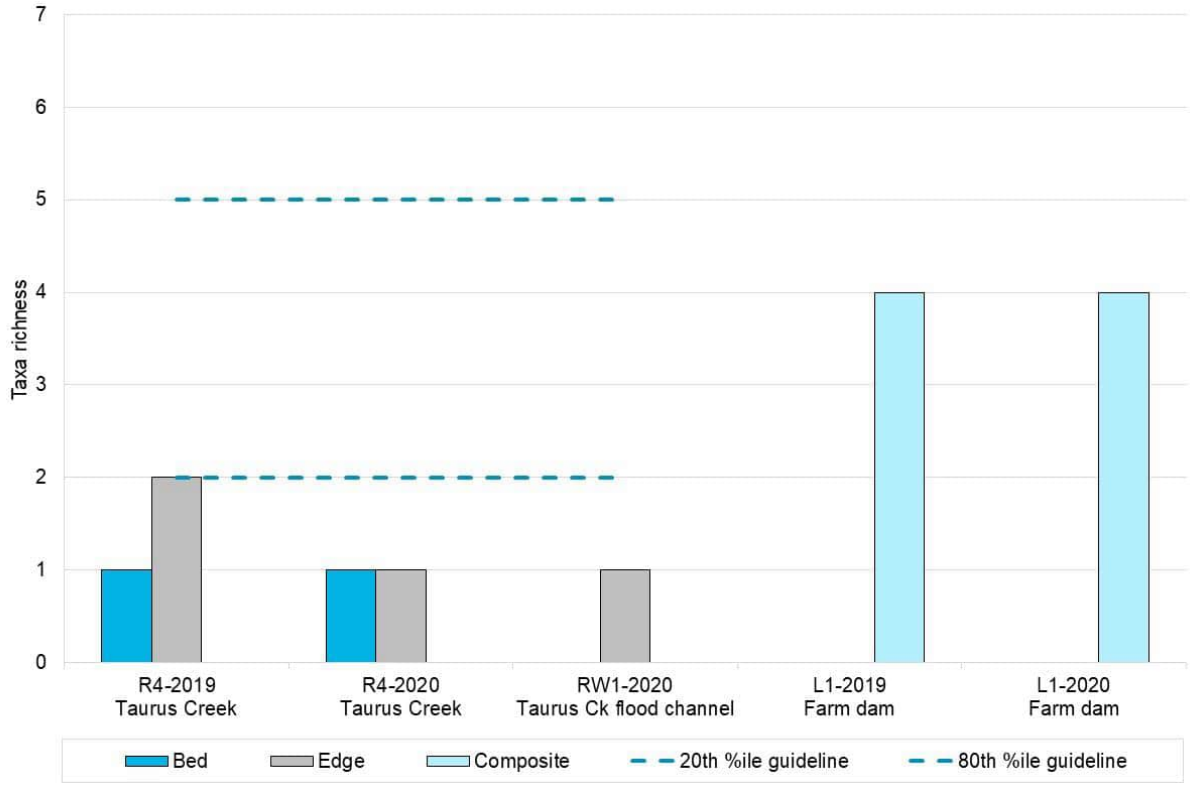


Plate 5.3 PET taxa richness of aquatic macroinvertebrate samples collected from the study area, December 2019 and May 2020

Pollution-tolerant taxa

The percentage of pollution tolerant taxa (SIGNAL 2 score of 1-3) ranged from 38 to 70% in the riverine bed samples, from 61 to 67% in the riverine edge sample, and from 41 to 52% in the farm dam samples. Data is presented against the DEHP (2011a) WQOs for the Mackenzie River Sub-basin waters. The WQOs apply to riverine systems only. As such, no guidelines are presented for the farm dam site L1.

The percentage of pollution tolerant taxa exceeded the DEHP (2011a) 20:80 percentile guideline range in most riverine samples, indicating unfavourable physical conditions and/or reduced habitat quality, and likely reflecting the highly ephemeral flow regime.

The composite sample collected from lacustrine wetland waterbody site L1 exhibited a favourably lower percentages of pollutant tolerant taxa compared to the riverine sites. This likely reflects the permanent wetted habitat at this site (Plate 5.4).

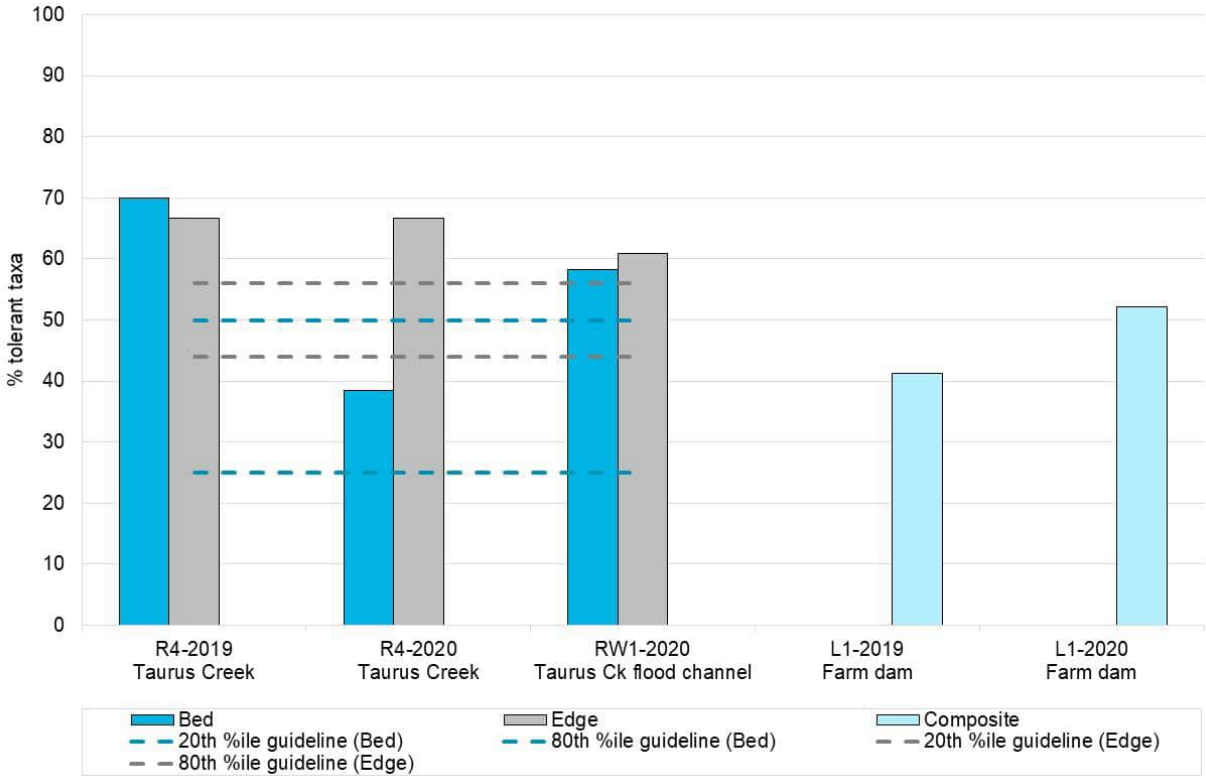


Plate 5.4 **Percentage of tolerant taxa in aquatic macroinvertebrate samples collected from the study area, December 2019 and May 2020**

SIGNAL2 scores

SIGNAL2 scores ranged from 3.08 to 3.69 for the riverine bed habitat samples, from 2.96 to 3.17 for the riverine edge habitat samples, and from 3.43 to 3.53 for the farm dam samples collected in December 2019 and May 2020. SIGNAL2 results are presented against the DEHP (2011a) WQOs for the Mackenzie River Sub-basin waters. The WQOs apply to riverine systems only. As such, no guidelines are presented for the farm dam site L1.

The SIGNAL2 scores for most bed and edge samples fell below the DEHP (2011a) 20:80 percentile guideline range, reflecting a lower composition of pollution sensitive taxa (and a higher composition of pollutant tolerant taxa) than what is expected for the Mackenzie River Sub-basin waters. This likely indicates unfavourable physical conditions and/or reduced habitat quality associated with high ephemerality.

SIGNAL2 scores for the composite samples collected from farm dam site L1 exhibited a favourably higher SIGNAL2 score compared to most other sites (Plate 5.5). This reflects the more stable wetted habitat and physico-chemical water quality expected in this more permanent waterbody.

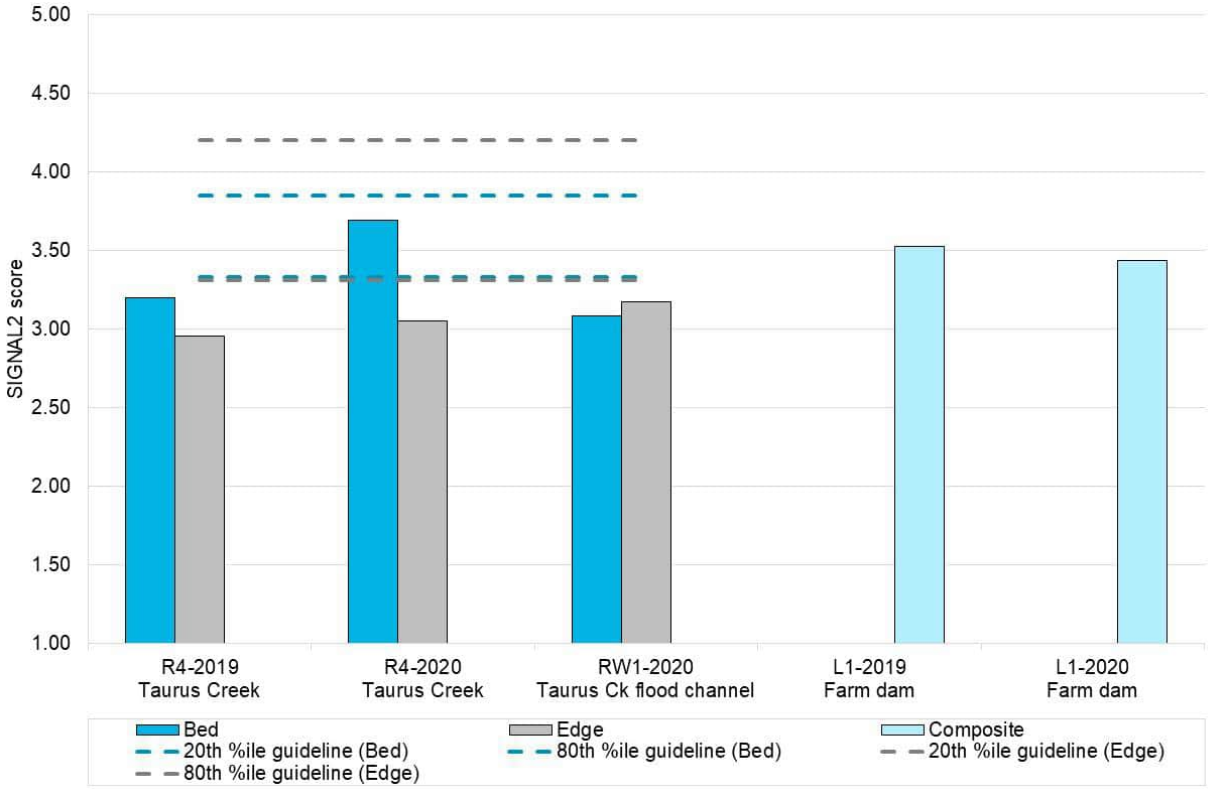


Plate 5.5 **SIGNAL2 scores for aquatic macroinvertebrate samples collected from the study area, December 2019 and May 2020**

AusRivAS OE50

Aquatic macroinvertebrate data from the December 2019 riverine sampling was modelled using the AusRivAS Queensland regional coastal spring models for the habitats sampled. Data from the May 2020 riverine sampling was modelled using the AusRivAS Queensland regional coastal autumn models for the habitats sampled.

AusRivAS observed to expected (OE50) taxa scores indicate that the bed habitat samples were impaired (Band B) at site R4 in December 2019 and May 2020 and severely impaired (Band C) at site RW1. No sites received a score within Band D (extremely impaired) (Plate 5.6). The edge habitat samples collected from site R4 in December 2019 and May 2020, and from site RW1 in May 2020, were in reference condition (Band A), representative of minimally disturbed sites used to build the AusRivAS models. The better scores in the edge habitats than in the bed habitats are reflective of the greater habitat complexity in the edge habitats.

The prevalence of wetted habitat is likely to be a key driver in macroinvertebrate community structure and ecosystem functioning, and caution is applied to the use of AusRivAS ratings in ephemeral systems. The lower (Band B and Band C) OE50 taxa scores for the bed habitat samples may be more reflective of seasonality than catchment impacts.

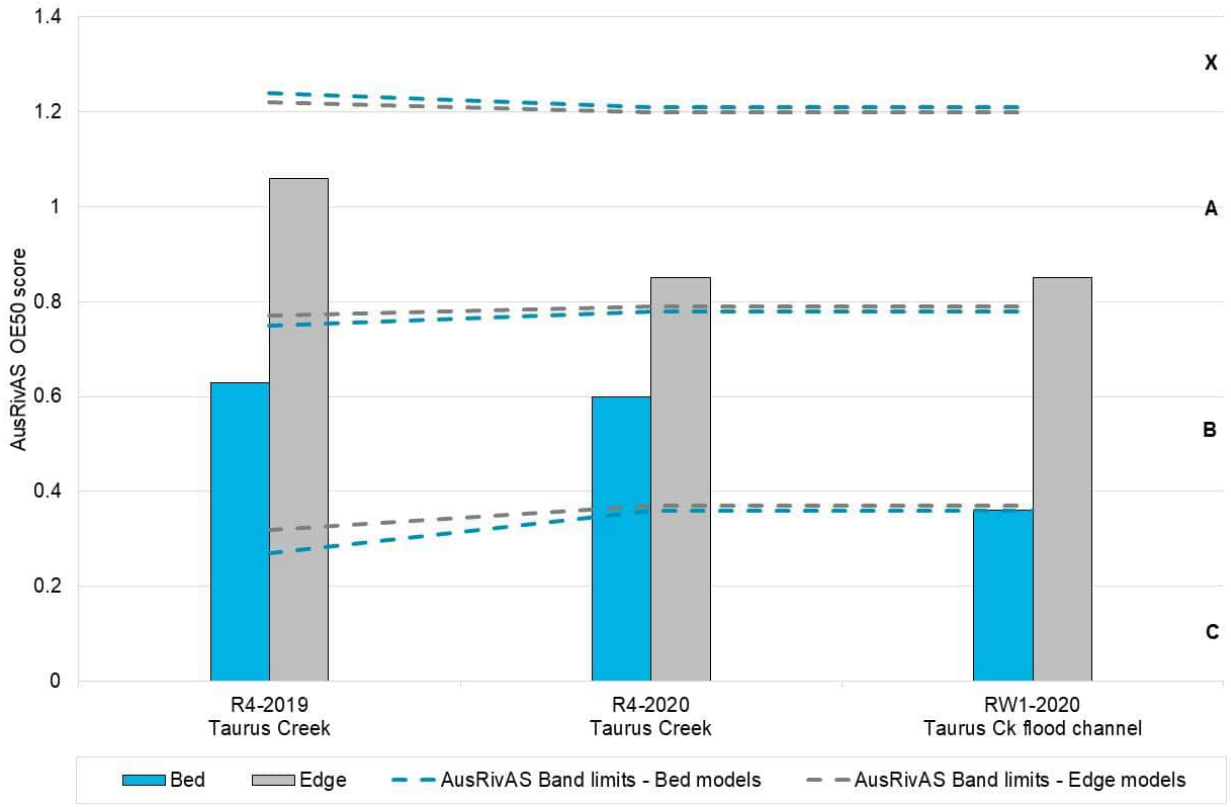


Plate 5.6 **AusRivAS OE50 scores for riverine macroinvertebrate samples collected from the study area, December 2019 and May 2020**

5.6 Conservation significant species

5.6.1 Aquatic flora

No CEEVNT aquatic flora species were recorded during the surveys. The Wetland*Info* database identifies five CEEVNT flora species that have previously been recorded from the broader Fitzroy Basin (DES 2020a) (Table 5.8), none of which were found as likely to occur within the study area.

Table 5.9 CEEVNT aquatic flora species recorded from the Fitzroy Basin

Scientific name	Common name	EPBC Act status[1]	NC Act status[2]	Preferred habitat	Likelihood of occurrence
Eriocaulon carsonii (including subsp. orientale)	salt pipewort/ button grass	E	E	Restricted to saturated soil adjacent to flowing mound springs (Sainty and Jacobs 2003).	**Unlikely**. Current known distribution (ALA 2020) is not in proximity to the study area. Mound springs not known to occur within the study area or surrounds. Species or species habitat not detected during field surveys.
Maundia triglochinoides	-	-	V	Grows in coastal freshwater swamps and streams (Sainty and Jacobs 2003), in waters up to 0.5 m deep, or shallow waters that may dry up seasonally.	**Unlikely**. Current known distribution (ALA 2020) is not in proximity to the study area. Species or species habitat not detected during field surveys.
Myriophyllum artesium	-	-	E	Wetlands and creek lines associated with springs emanating from the Great Artesian Basin and associated basins (DES 2020e).	**Unlikely**. Current known distribution (ALA 2020) is not in proximity to the study area. GAB spring fed wetlands and creeks not known to occur within the study area or surrounds. Species or species habitat not detected during field surveys.
Phaius australis	lesser swamp orchid	E	E	Grows in sandy areas where soils are almost always damp, but not flooded for lengthy periods; occurring in southern Queensland and northern NSW (DES 2020f).	**Unlikely**. Current known distribution (ALA 2020) is not in proximity to the study area. Species or species habitat not detected during field surveys.
Thelypteris confluens	swamp fern	-	V	Found in permanently swampy areas and mound springs (DES 2020g). Occurs in the Queensland pastoral districts on Leichhardt, Moreton and Wide Bay (DES 2020g).	**Unlikely**. Current known distribution (ALA 2020) is not in proximity to the study area. Species or species habitat not detected during field surveys.

1. EPBC Act status: CE – critically endangered, E – endangered, V – vulnerable
2. NC Act status: CE – critically endangered, E – endangered, V – vulnerable, NT – near threatened, SLC – special least concern, LC – Least Concern

5.6.2 Fish

No CEEVNT fish species were recorded during the surveys. The Wetland*Info* database identifies 53 fish species that have previously been recorded from the broader Fitzroy Basin (DES 2020a). Of these, two are listed as CEEVNT:

- Silver perch (*Bidyanus bidyanus*) – Critically Endangered (EPBC Act)
- Murray cod (*Maccullochella peelii*) – Vulnerable (EPBC Act).

Due to habitat requirements and distributional range (Table 5.10), it is unlikely these CEEVNT species occur within waterbodies of the study area as either resident or transient occurrences.

Table 5.10 CEEVNT fish species recorded from the Fitzroy Basin

Scientific name	Common name	EPBC Act status[1]	NC Act status[2]	Preferred habitat	Likelihood of occurrence
Bidyanus bidyanus	Silver perch	CE	LC	Faster-flowing water, including rapids and races, and more open sections of river, throughout the Murray-Darling Basin (MDB) (Clunie and Koehn 2001, cited in TSSC 2013).	**Unlikely**. Distributional range is naturally in the MDB, although translocated to coast streams in south-east Queensland (and other states). Species or species habitat not detected during field surveys.
Maccullochella peelii	Murray cod	V	LC	Deep water with in-stream habitat such as boulders, logs, and overhanging vegetation (Allen et al. 2002). From fast-moving, clear upland streams to slow-flowing, turbid lowland waters. Most individuals stay within 10 km reach of the river (Pusey et al. 2004; Allen et al. 2002).	**Unlikely**. Outside of natural area of distribution (ALA 2020). Species or species habitat not detected during field surveys.

1. EPBC Act status: CE – critically endangered, E – endangered, V – vulnerable
2. NC Act status: CE – critically endangered, E – endangered, V – vulnerable, NT – near threatened, SLC – special least concern, LC – Least Concern

5.6.3 Turtles

No CEEVNT freshwater turtle species were recorded during the surveys.

The Wetland*Info* database identifies seven freshwater turtle species as having previously been recorded from the Fitzroy Basin (DES 2020a). Of these, two are listed as CEEVNT:

- Southern snapping turtle (*Elseya albagula*) – Critically Endangered (EPBC Act), Endangered (NC Act); and
- Fitzroy River turtle (*Rheodytes leukops*) – Vulnerable (EPBC Act and NC Act).

The southern snapping turtle and Fitzroy River turtle are 'known' from the search area for the EPBC Act PMST report (DEE 2020a) (Appendix A). However, due to habitat requirements and distributional range, it is unlikely that these CEEVNT turtle species occur within waterbodies of the study area as either resident or transient occurrences (Table 5.11).

Table 5.11 CEEVNT freshwater turtle species recorded from the Fitzroy Basin

Scientific name	Common name	EPBC Act status[1]	NC Act status[2]	Preferred habitat	Likelihood of occurrence
Rheodytes leukops	Fitzroy River turtle	V	V	Fast-flowing water of the Fitzroy River and its tributaries (Cogger 2014). Rivers with large deep pools and rocky, gravelly or sandy substrates, connected by shallow riffles. Preferred areas have high water clarity and are often associated with ribbonweed (*Vallisneria* sp.) (DEE 2020c).	**Unlikely**. Current known distribution is within the Fitzroy Basin. However due to a lack of suitable habitat, including ephemeral waterways with no deep pools, it is unlikely the species would occur in waterbodies of the study area. Both as residents or transient occurrences.
Elseya albagula	Southern snapping turtle	CE	E	Permanent flowing water habitats where there are suitable shelters and refuges (DES 2020h); clear, flowing, well-oxygenated waters (Todd et al. 2013) of the Fitzroy, Mary and Burnett catchments.	**Unlikely**. Current known distribution is within the Fitzroy Basin. However due to a lack of suitable habitat, including ephemeral waterways with no permanent flowing water, it is unlikely the species would occur in waterbodies of the study area. Both as residents or transient occurrences.

1. EPBC Act status: CE – critically endangered, E – endangered, V – vulnerable
2. NC Act status: CE – critically endangered, E – endangered, V – vulnerable, NT – near threatened, SLC – special least concern, LC – Least Concern

5.6.4 Platypus

The platypus *(Ornithorhynchus anatinus*) was not recorded during field surveys.

The seasonal nature of the riverine waterbodies of the study area are not conducive to sustaining a population of platypus. Similarly, the lacustrine waterbodies (i.e., farm dams) of the study area are unlikely to sustain a population of platypus as, despite relative permanence of wetted habitat, these waterbodies lack the banks suitable for platypus burrow construction.

5.6.5 Invertebrates

No aquatic invertebrates are identified in the EPBC Act PMST report (DEE 2020a). The Wetland*info* database for the Fitzroy Basin (DES 2020a) identifies two macro-crustaceans and 23 wetland indicator insects as having previously been recorded from the Fitzroy Basin, none of which are listed in the EPBC Act or NC Act.

5.7 Introduced species

5.7.1 Introduced aquatic flora

There are 23 introduced wetland indicator plant species known from the Fitzroy Basin (DES 2020a). Those invasive species considered to pose a particular threat to aquatic biodiversity, and that could potentially occur within the study area, are listed in either a Weed of National Significance (WoNS) (DEE 2020d) or Restricted matter category 3 under the *Queensland Biosecurity Act 2014*. Only two of these species were recorded in the study area: Awnless Barnyard Grass (*Echinochloa colona*) and White Eclipta (*Eclipta prostrata*). Neither are of ecological significance.

Table 5.12 Introduced aquatic flora

Scientific name	Common name	National status[1]	Qld Biosecurity Act status[2]
Arundo donax	Giant Reed		
Cyperus esculentus	Yellow Nutgrass		
Cyperus involucratus	Umbrella Sedge		
Cyperus papyrus	Papyrus		
Diplachne fusca var. uninervia	-		
Echinochloa colona	**Awnless Barnyard Grass**		
Echinochloa crus-galli	Barnyard Grass		
Eclipta prostrata	**White Eclipta**		
Eichhornia crassipes	Water Hyacinth	WoNS	Restricted 3
Eleocharis minuta	Spike Rush		
Hymenachne amplexicaulis 'Olive'	Olive Hymenachne	WoNS	Restricted 3
Juncus bufonius	Toad Rush		
Nymphaea caerulea	Cape Waterlily		
Paspalum distichum	Water Couch		
Paspalum vaginatum	Saltwater Couch		
Pistia stratiotes	Water Lettuce		Restricted 3
Polypogon monspeliensis	Annual Beardgrass		
Rorippa nasturtium-aquaticum	Watercress		
Salix babylonica	Weeping Willow		
Salvinia molesta	Salvinia	WoNS	Restricted 3
Sparganium erectum subsp. *stoloniferum*	Erect Bur-Reed		
Stenotaphrum secundatum	Buffalo Grass		
Urochloa mutica	Para Grass		

1. Species listed as WoNS
2. Species listed under the Queensland *Biosecurity Act 2014*
3. *Bold text indicates species detected from the study area in December 2019 and/or May 2020.*

5.7.2 Pest fish species

Six introduced fish species have been recorded from the Fitzroy Basin: mosquitofish (*Gambusia holbrooki*), guppy (*Poecilia reticulata*), goldfish (*Carassius auratus*), European carp (*Cyprinus carpio*) (DES 2020a), tilapia (*Oreochromus mossambicus*) (DPM Enviroscences 2018; Catchment Solutions 2015) and platy (*Xiphophorus maculatus*) (Catchment Solutions 2015).

One pest fish species was encountered during the December 2019 and May 2020 aquatic surveys, being mosquitofish (*Gambusia holbrooki*), recorded from lacustrine waterbody (farm dam) site L1 on Sagittarius Creek.

The mosquitofish is a noxious species listed as restricted categories 3, 5, 6 and 7 in the *Biosecurity Act 2014*. This species was introduced into Australia from North America in 1929 as a biological control for mosquitos; however, this was unsuccessful and the species is now regarded as one of the greatest threats to Australia's native biodiversity (Business Queensland 2020). The mosquitofish has many traits that make them a good invader such as high reproductive potential, flexible diet, broad environmental tolerances and low vulnerability to predation due to burrowing habit, and they have the potential to rapidly outnumber native fish and dominate aquatic communities (Business Queensland 2020).

Native fish or macroinvertebrate communities within site L1 did not appear to be adversely affected by the presence of mosquitofish.

5.7.3 Introduced aquatic reptiles

No introduced aquatic reptile species were recorded during the surveys and none were identified from the desktop review as having potential to occur in the study area.

5.8 Groundwater dependent ecosystems

The EPBC Act lists '*a water resource, in relation to coal seam gas development and large coal mining development*' as a MNES. A water resource is defined under the Commonwealth *Water Act 2007* and incorporates ecosystems that contribute to the physical state and environmental value of the water resource. As such, environmental assessments for large coal mines are required to identify potential GDEs and assess and manage potential impacts to GDEs (IESC 2018).

The GDE Assessment Framework allows technical investigations to determine where GDEs exist within the landscape, and provides the necessary technical information to establish the ecological water requirements (EWRs), which define the intrinsic requirement an ecosystem has for water (Richardson et al. 2011a).

The framework contains three stages of assessment which should be applied to determine EWRs for GDEs. They are:

- **Stage 1 assessment**: defines the extent and location of potential GDEs. This includes determining where the ecosystems are potentially using groundwater and what the broad type of GDE is (further discussed below).
- **Stage 2 assessment**: characterises the potential reliance of the GDE on groundwater and determines if groundwater is part of the ecosystem.
- **Stage 3 assessment**: determining threats to the groundwater system and ecosystem, and how might the current ecosystem change if the groundwater system changes. The long-term state of the ecosystem is also assessed.

This report assesses the potential presence of Type 2 GDEs.

Type 1 and Type 3 GDEs are assessed in separate reports. For Type 2 GDEs also referred to as aquatic GDEs, only stage 1 and stage 2 assessments were conducted. Type 2 GDEs are ecosystems dependent on surface expression of groundwater such as wetlands, lakes, springs and river baseflow. In these cases, groundwater extends above earth surface, as a visible expression. These can be obligate or facultative GDEs (Richardson et al. 2011a).

GDEs within the study area were placed into one of the three types described by Richardson et al. (2011a). They were then allocated into groundwater dependency types being:

1. Facultative (i.e., have some degree of dependence on groundwater)
2. Entirely dependent/obligate (i.e., essential to ecosystem functioning).

Ecosystems with a facultative dependence can be further divided into three sub-categories, including:

- opportunistic: these ecosystems will use groundwater where available, but can exist without the input of groundwater, as long as there is no prolonged drought. Examples of opportunistic ecosystems include some swamp forests, riparian forests and woodlands.

- proportional: these ecosystems take a proportion of their water requirements from groundwater, however there is no absolute threshold for groundwater availability below which ecosystem structure or function is impaired, and can respond to changes in groundwater at any level. Examples of proportional ecosystems include glacial lakes and alpine bogs.

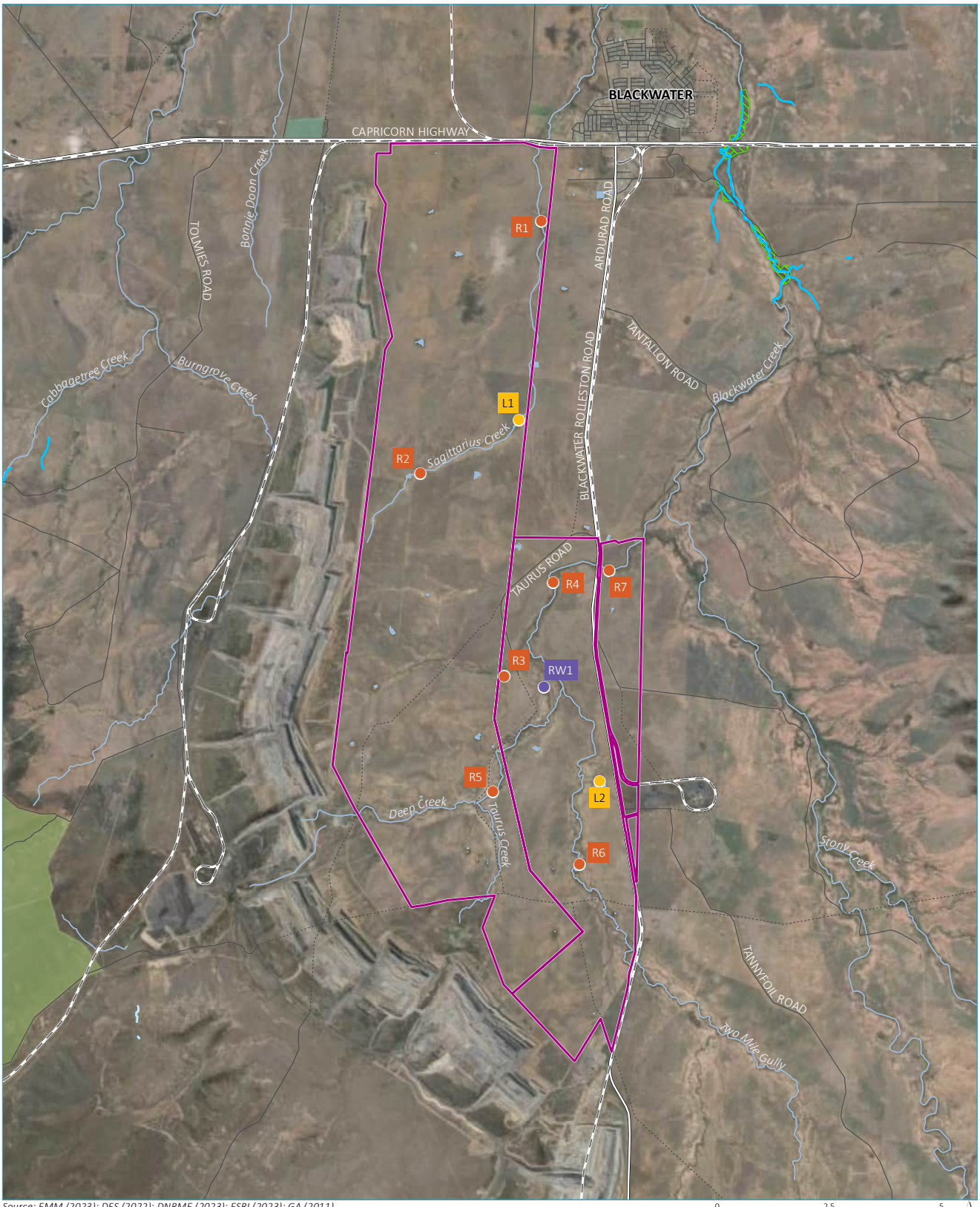
- highly dependent: these ecosystems take a high proportion of their water requirements from groundwater and can only tolerate small changes in groundwater levels for short periods of time. Examples of highly dependent ecosystems include upland swamps in the Sydney Basin, Paperbark swamps in northern Australia and wetlands of the basalt plains in Victoria.

Type 2 GDEs are identified within the study area in broad-scale potential GDE mapping (DES 2020d). No aquatic GDE's were identified within the study area, however, were identified to the north-east/ east of the study area, east of the town of Blackwater, in Blackwater Creek.

5.8.1 Type 2 GDEs - aquatic GDEs

Desktop mapping of potential aquatic GDEs throughout Queensland (DES 2020d) shows no 'known' or 'derived' surface expression GDEs within the study area. 'Derived' surface expression GDE lines and areas of 'moderate confidence' are identified in the DES (2020d) mapping (Figure 5.5) to the north-east/ east of the study area on Blackwater Creek.

Surveys in December 2019 were undertaken following a prolonged dry period (Section 3.1). The minimal rainfall and runoff in the lead-up to the survey assisted in differentiating aquatic ecosystems dependent on surface water runoff, and those potentially dependent on the surface expression of groundwater. The concentration and relative proportion of major anions and cations in surface water samples collected from the study area in December 2019 and May 2020 show no obvious groundwater influence (Section 5.2.2). No surface GDEs were encountered within the study area.



Source: EMM (2023); DES (2022); DNRME (2023); ESRI (2023); GA (2011)

0 2.5 5 km

GDA2020 MGA Zone 55

N

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KEY

- Study area

Existing environment

- Rail line
- Major road
- Minor road
- Vehicular track
- Dam/waterbody
- National park/nature reserve
- State forest

Surface GDE lines

- Derived GDE - moderate confidence
- Derived GDE - low confidence

Surface GDE areas

- 01-80% derived GDE - moderate confidence

Aquatic sites surveyed

- Riverine drainage system
- Riverine wetland/waterbody
- Lacustrine waterbody

State mapped surface expression groundwater dependent ecosystems (GDEs)

BMA - Blackwater Mine
Aquatic Ecology Baseline Assessment
Figure 5.5

EMM creating opportunities

5.9 Matters of National Environmental Significance

World and National Heritage properties

No World Heritage Properties or National Heritage Places are identified for the search area in the EPBC Act Protected Matters report (DEE 2020a, Appendix A).

Wetlands of International Importance

No wetlands of international importance are identified within the search area in the EPBC Act Protected Matters Report (DAWE 2020a, Appendix A). Wetlands of international importance nearest to the study area include those of the Shoalwater and Corio Bays Area (DAWE 2020b), approximately 200 km to the northeast. These wetlands are well removed from the study area and are hydraulically connected only by the Coral Sea.

Threatened Ecological Communities

No EPBC Act listed TECs, relevant to aquatic ecology, are identified from the search area (DAWE 2020a). No aquatic TECs are expected to occur within the study area.

Threatened species

No MNES aquatic flora or fauna species were detected during field surveys.

Aquatic fauna species that are MNES which are considered to have potential to occur in the broader desktop search area include the Critically Endangered southern snapping turtle (*Elseya albagula*), Critically Endangered silver perch (*Bidyanus bidyanus*), Vulnerable Murray cod (*Maccullochella peelii*), and the Vulnerable Fitzroy River turtle (*Rheodytes leukops*), each listed under the EPBC Act. However, due to habitat requirements, it is unlikely these species occur within waterbodies of the study area as either resident or transient occurrences. Suitable habitat for these species was not encountered within the study area.

No MNES aquatic flora species are likely to occur within the study area.

Aquatic Migratory Species

No aquatic migratory species (ie migratory species that live in water for most or all their lives) are identified from the search area.

Commonwealth Marine Areas

The study area is located approximately 200 km west (direct line) of any marine area (DAWE 2020b) and is separated hydraulically by at least two sub-catchments (Dawson River and the Fitzroy River) with varying land use and water quality.

Nuclear actions (including uranium mines)

The Action does not involve any nuclear actions.

Water resource

A water resource, in relation to coal seam gas development and large coal mining development, is a controlling provision under the EPBC Act of relevance to the proposed extension of mining into SA10 and SA7 and would be addressed as per the Information Guidelines for Independent Expert Scientific Committee advice on coal seam gas and large coal mining development proposals (IESC 2018).

5.10 Matters of State Environmental Significance

The environmental offsets framework in Queensland includes the EO Act, the EO Regulation and the EO Policy. MSES are defined in the EO Regulation and are a component of the biodiversity state interest identified in the Queensland State Planning Policy.

MSES were identified during the desktop review as occurring within the study area (Table 5.13). MSES of relevance to this aquatic ecology assessment comprise 'waterways providing for fish passage' (Figure 5.3).

Table 5.13 Aquatic Matters of State Environmental Significance located in the study area

Prescribed Environmental Matter	Present in the study area	Detail
Regulated vegetation	-	Refer to terrestrial ecology assessment.
Connectivity areas	-	Refer to terrestrial ecology assessment.
Wetlands and watercourses	No	No wetlands of high ecological significance or wetlands or watercourses in high ecological value waters are identified for the study area or surrounds (Figure 5.1, Figure 5.2, and Figure 5.4). Watercourse vegetation is assessed in terrestrial ecology assessment.
Protected Wildlife Habitat	-	Refer to terrestrial ecology assessment. No CEEVNT aquatic species observed or assessed as likely to occur. SLC platypus is more likely to be encountered within semi-permanent riverine waterbodies such as those upstream from a weir. No burrows were observed in the study area, nor are they considered likely to occur.
Koala Habitat in South-East Queensland	-	The study area is not located in South-east Queensland.
Protected Areas	-	Refer to terrestrial ecology assessment.
Fish Habitat Areas and Highly Protected Zones of State Marine Parks	No	The study area is not located in a State Marine Park.
Waterway providing for fish passage	Yes	Waterways within the study area provide for fish passage (Table 5.3)
Marine Plants	No	The study area is not located in a marine environment.
Secured Offset Area	-	Refer to terrestrial ecology assessment.

6 Conclusion

The waterways of the study area are predominantly first and second order tributaries. There are sections of waterways ranging up to the fourth order including Two Mile Gully and Taurus Creek. Taurus Creek then flows north into Blackwater Creek as a fifth order stream. Mapped wetlands in the north are comprised of one small lacustrine wetland waterbody (farm dam). A number of smaller, unmapped lacustrine wetland waterbodies (farm dams and a flood channel wetland) also occur.

The waterways of the study area are ephemeral and are generally expected to experience flow only after sustained or intense rainfall and runoff in the catchment. Stream flows are expected to be highly variable, with most channels expected to dry during winter to early spring when rainfall and runoff is historically low. Consequently, physical attributes, water quality, and the composition of aquatic flora and fauna communities are expected to be highly variable over time.

Aquatic survey was attempted at nine locations in December 2019, comprising six waterways, and two lacustrine wetland waterbodies. With most waterways being dry at the time of assessment, habitat assessments were undertaken in place of detailed aquatic survey at most riverine sites. Most lacustrine waterbodies (farm dams) held water at the time of assessment. The same sites were again sampled in May 2020 to capture a complete seasonal dataset. An additional site, site RW1 – being an unmapped flood channel wetland on Taurus Creek – was opportunistically sampled in May 2020 due to the persistence of wetted habitat that was not encountered in this area in December 2019.

No conservation significant aquatic flora or fauna species listed under the NC Act and/or EPBC Act were recorded from the study area. Due to habitat requirements and distributional range, it is unlikely that any CEEVNT aquatic flora or fauna species occur within the waterways or wetlands of the study area as either resident or transient occurrences.

There are no wetlands of International Importance or National Importance identified within the study area.

MSES of relevance to this aquatic ecology assessment include waterways providing for fish passage, which is an MSES only if a waterway barrier work is proposed that would limit the passage of fish along the waterway. There were no HES wetlands in the study area and no aquatic species listed under EPBC Act or NC Act were observed or assessed as likely to occur.

A water resource, in relation to coal seam gas development and large coal mining development, is an MNES relevant to aquatic ecology. GDEs are a component of the water resource MNES. State mapping indicates no ‘known’ or ‘derived’ surface expression GDEs within the study area. Prolonged dry conditions in the lead-up to the December 2019 surveys provided ideal conditions for identifying surface expressions of groundwater (i.e. aquatic GDEs). However, no flows, salt seeps, hydrophytes or other obvious indicators of aquatic GDEs were encountered. Further, the concentration and relative proportion of major anions and cations in surface water samples collected from the survey area in December 2019 and May 2020 showed no obvious groundwater influence. Field verification of riparian vegetation and aquatic habitats of the study area found no obvious on-ground indicators of aquatic GDEs.

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Appendix A
Desktop searches

EMM
creating opportunities

Australian Government
Department of the Environment and Energy

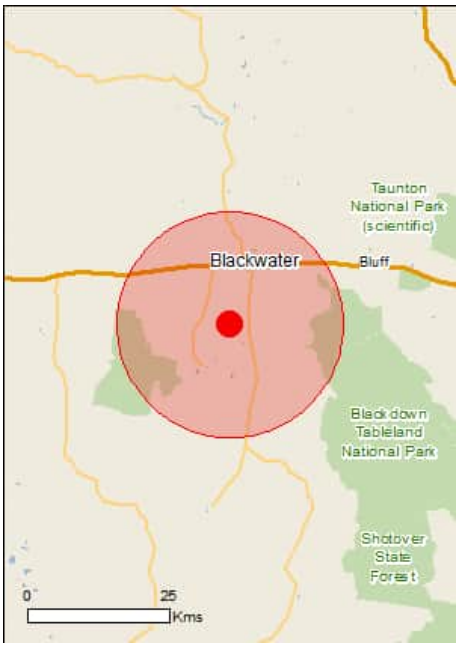
EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected.

Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

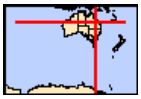
Information is available about Environment Assessments and the EPBC Act including significance guidelines, forms and application process details.

Report created: 10/01/20 10:06:07



This map may contain data which are ©Commonwealth of Australia (Geoscience Australia), ©PSMA 2010

Coordinates
Buffer: 20.0Km



Summary

Matters of National Environmental Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Importance:	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	None
Listed Threatened Ecological Communities:	6
Listed Threatened Species:	28
Listed Migratory Species:	12

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at http://www.environment.gov.au/heritage

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Land:	1
Commonwealth Heritage Places:	None
Listed Marine Species:	18
Whales and Other Cetaceans:	None
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	None

Extra Information

This part of the report provides information that may also be relevant to the area you have nominated.

State and Territory Reserves:	2
Regional Forest Agreements:	None
Invasive Species:	21
Nationally Important Wetlands:	None
Key Ecological Features (Marine)	None

Details

Matters of National Environmental Significance

Listed Threatened Ecological Communities [Resource Information]

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Name	Status	Type of Presence
Brigalow (Acacia harpophylla dominant and co-dominant)	Endangered	Community known to occur within area
Coolibah - Black Box Woodlands of the Darling Riverine Plains and the Brigalow Belt South Bioregions	Endangered	Community may occur within area
Natural Grasslands of the Queensland Central Highlands and northern Fitzroy Basin	Endangered	Community likely to occur within area
Poplar Box Grassy Woodland on Alluvial Plains	Endangered	Community likely to occur within area
Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions	Endangered	Community likely to occur within area
Weeping Myall Woodlands	Endangered	Community likely to occur within area

Listed Threatened Species [Resource Information]

Name	Status	Type of Presence
Birds		
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Erythrotriorchis radiatus Red Goshawk [942]	Vulnerable	Species or species habitat likely to occur within area
Geophaps scripta scripta Squatter Pigeon (southern) [64440]	Vulnerable	Species or species habitat known to occur within area
Grantiella picta Painted Honeyeater [470]	Vulnerable	Species or species habitat may occur within area
Neochmia ruficauda ruficauda Star Finch (eastern), Star Finch (southern) [26027]	Endangered	Species or species habitat likely to occur within area
Poephila cincta cincta Southern Black-throated Finch [64447]	Endangered	Species or species habitat may occur within area
Rostratula australis Australian Painted Snipe [77037]	Endangered	Species or species habitat likely to occur within area
Turnix melanogaster Black-breasted Button-quail [923]	Vulnerable	Species or species habitat may occur within area

Name	Status	Type of Presence
Mammals		
Chalinolobus dwyeri Large-eared Pied Bat, Large Pied Bat [183]	Vulnerable	Species or species habitat likely to occur within area
Dasyurus hallucatus Northern Quoll, Digul [Gogo-Yimidir], Wijingadda [Dambimangari], Wiminji [Martu] [331]	Endangered	Species or species habitat likely to occur within area
Macroderma gigas Ghost Bat [174]	Vulnerable	Species or species habitat likely to occur within area
Nyctophilus corbeni Corben's Long-eared Bat, South-eastern Long-eared Bat [83395]	Vulnerable	Species or species habitat may occur within area
Petauroides volans Greater Glider [254]	Vulnerable	Species or species habitat likely to occur within area
Phascolarctos cinereus (combined populations of Qld, NSW and the ACT) Koala (combined populations of Queensland, New South Wales and the Australian Capital Territory) [85104]	Vulnerable	Species or species habitat likely to occur within area
Plants		
Bertya opponens [13792]	Vulnerable	Species or species habitat likely to occur within area
Cadellia pentastylis Ooline [9828]	Vulnerable	Species or species habitat likely to occur within area
Daviesia discolor [3567]	Vulnerable	Species or species habitat known to occur within area
Dichanthium queenslandicum King Blue-grass [5481]	Endangered	Species or species habitat may occur within area
Dichanthium setosum bluegrass [14159]	Vulnerable	Species or species habitat may occur within area
Homoranthus decumbens a shrub [55186]	Endangered	Species or species habitat may occur within area
Macrozamia platyrhachis cycad [3412]	Endangered	Species or species habitat likely to occur within area
Polianthion minutiflorum [82772]	Vulnerable	Species or species habitat likely to occur within area
Solanum dissectum [75720]	Endangered	Species or species habitat may occur within area
Reptiles		
Delma torquata Adorned Delma, Collared Delma [1656]	Vulnerable	Species or species habitat likely to occur within area
Denisonia maculata Ornamental Snake [1193]	Vulnerable	Species or species habitat known to occur within area
Egernia rugosa Yakka Skink [1420]	Vulnerable	Species or species

Name	Status	Type of Presence
		habitat known to occur within area
Elseya albagula		
Southern Snapping Turtle, White-throated Snapping Turtle [81648]	Critically Endangered	Species or species habitat likely to occur within area
Rheodytes leukops		
Fitzroy River Turtle, Fitzroy Tortoise, Fitzroy Turtle, White-eyed River Diver [1761]	Vulnerable	Species or species habitat likely to occur within area

Listed Migratory Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Migratory Marine Birds		
Apus pacificus		
Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Migratory Terrestrial Species		
Cuculus optatus		
Oriental Cuckoo, Horsfield's Cuckoo [86651]		Species or species habitat may occur within area
Monarcha melanopsis		
Black-faced Monarch [609]		Species or species habitat likely to occur within area
Motacilla flava		
Yellow Wagtail [644]		Species or species habitat may occur within area
Myiagra cyanoleuca		
Satin Flycatcher [612]		Species or species habitat may occur within area
Rhipidura rufifrons		
Rufous Fantail [592]		Species or species habitat may occur within area
Migratory Wetlands Species		
Actitis hypoleucos		
Common Sandpiper [59309]		Species or species habitat may occur within area
Calidris acuminata		
Sharp-tailed Sandpiper [874]		Species or species habitat likely to occur within area
Calidris ferruginea		
Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Calidris melanotos		
Pectoral Sandpiper [858]		Species or species habitat may occur within area
Gallinago hardwickii		
Latham's Snipe, Japanese Snipe [863]		Species or species habitat may occur within area
Pandion haliaetus		
Osprey [952]		Species or species habitat likely to occur within area

Other Matters Protected by the EPBC Act

Commonwealth Land [Resource Information]

The Commonwealth area listed below may indicate the presence of Commonwealth land in this vicinity. Due to the unreliability of the data source, all proposals should be checked as to whether it impacts on a Commonwealth area, before making a definitive decision. Contact the State or Territory government land department for further information.

Name
Defence - BLACKWATER TRAINING DEPOT

Listed Marine Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Birds		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat may occur within area
Anseranas semipalmata Magpie Goose [978]		Species or species habitat may occur within area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardea alba Great Egret, White Egret [59541]		Species or species habitat likely to occur within area
Ardea ibis Cattle Egret [59542]		Species or species habitat may occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat likely to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Chrysococcyx osculans Black-eared Cuckoo [705]		Species or species habitat likely to occur within area
Gallinago hardwickii Latham's Snipe, Japanese Snipe [863]		Species or species habitat may occur within area
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat likely to occur within area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area
Monarcha melanopsis Black-faced Monarch [609]		Species or species habitat likely to occur within area
Motacilla flava Yellow Wagtail [644]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
Myiagra cyanoleuca Satin Flycatcher [612]		Species or species habitat may occur within area
Pandion haliaetus Osprey [952]		Species or species habitat likely to occur within area
Rhipidura rufifrons Rufous Fantail [592]		Species or species habitat may occur within area
Rostratula benghalensis (sensu lato) Painted Snipe [889]	Endangered*	Species or species habitat likely to occur within area

Extra Information

State and Territory Reserves [Resource Information]

Name	State
Blackdown Tableland	QLD
Blackwater	QLD

Invasive Species [Resource Information]

Weeds reported here are the 20 species of national significance (WoNS), along with other introduced plants that are considered by the States and Territories to pose a particularly significant threat to biodiversity. The following feral animals are reported: Goat, Red Fox, Cat, Rabbit, Pig, Water Buffalo and Cane Toad. Maps from Landscape Health Project, National Land and Water Resouces Audit, 2001.

Name	Status	Type of Presence
Birds		
Columba livia Rock Pigeon, Rock Dove, Domestic Pigeon [803]		Species or species habitat likely to occur within area
Passer domesticus House Sparrow [405]		Species or species habitat likely to occur within area
Streptopelia chinensis Spotted Turtle-Dove [780]		Species or species habitat likely to occur within area
Sturnus vulgaris Common Starling [389]		Species or species habitat likely to occur within area
Frogs		
Rhinella marina Cane Toad [83218]		Species or species habitat known to occur within area
Mammals		
Bos taurus Domestic Cattle [16]		Species or species habitat likely to occur within area
Canis lupus familiaris Domestic Dog [82654]		Species or species habitat likely to occur within area
Felis catus Cat, House Cat, Domestic Cat [19]		Species or species habitat likely to occur within area
Lepus capensis Brown Hare [127]		Species or species habitat likely to occur

Name	Status	Type of Presence within area
Mus musculus House Mouse [120]		Species or species habitat likely to occur within area
Oryctolagus cuniculus Rabbit, European Rabbit [128]		Species or species habitat likely to occur within area
Rattus rattus Black Rat, Ship Rat [84]		Species or species habitat likely to occur within area
Sus scrofa Pig [6]		Species or species habitat likely to occur within area
Vulpes vulpes Red Fox, Fox [18]		Species or species habitat likely to occur within area
Plants		
Acacia nilotica subsp. indica Prickly Acacia [6196]		Species or species habitat may occur within area
Cryptostegia grandiflora Rubber Vine, Rubbervine, India Rubber Vine, India Rubbervine, Palay Rubbervine, Purple Allamanda [18913]		Species or species habitat likely to occur within area
Lantana camara Lantana, Common Lantana, Kamara Lantana, Large-leaf Lantana, Pink Flowered Lantana, Red Flowered Lantana, Red-Flowered Sage, White Sage, Wild Sage [10892]		Species or species habitat likely to occur within area
Opuntia spp. Prickly Pears [82753]		Species or species habitat likely to occur within area
Parkinsonia aculeata Parkinsonia, Jerusalem Thorn, Jelly Bean Tree, Horse Bean [12301]		Species or species habitat likely to occur within area
Parthenium hysterophorus Parthenium Weed, Bitter Weed, Carrot Grass, False Ragweed [19566]		Species or species habitat likely to occur within area
Vachellia nilotica Prickly Acacia, Blackthorn, Prickly Mimosa, Black Piquant, Babul [84351]		Species or species habitat likely to occur within area

Caveat

The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the Environment Protection and Biodiversity Conservation Act 1999. It holds mapped locations of World and National Heritage properties, Wetlands of International and National Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various resolutions.

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other information sources.

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Threatened, migratory and marine species distributions have been derived through a variety of methods. Where distributions are well known and if time permits, maps are derived using either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc) together with point locations and described habitat; or environmental modelling (MAXENT or BIOCLIM habitat modelling) using point locations and environmental data layers.

Where very little information is available for species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc). In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More reliable distribution mapping methods are used to update these distributions as time permits.

Only selected species covered by the following provisions of the EPBC Act have been mapped:

- migratory and
- marine

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:

- threatened species listed as extinct or considered as vagrants
- some species and ecological communities that have only recently been listed
- some terrestrial species that overfly the Commonwealth marine area
- migratory species that are very widespread, vagrant, or only occur in small numbers

The following groups have been mapped, but may not cover the complete distribution of the species:

- non-threatened seabirds which have only been mapped for recorded breeding sites
- seals which have only been mapped for breeding sites near the Australian continent

Such breeding sites may be important for the protection of the Commonwealth Marine environment.

Coordinates

-23.67025 148.84309

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

-Office of Environment and Heritage, New South Wales
-Department of Environment and Primary Industries, Victoria
-Department of Primary Industries, Parks, Water and Environment, Tasmania
-Department of Environment, Water and Natural Resources, South Australia
-Department of Land and Resource Management, Northern Territory
-Department of Environmental and Heritage Protection, Queensland
-Department of Parks and Wildlife, Western Australia
-Environment and Planning Directorate, ACT
-Birdlife Australia
-Australian Bird and Bat Banding Scheme
-Australian National Wildlife Collection
-Natural history museums of Australia
-Museum Victoria
-Australian Museum
-South Australian Museum
-Queensland Museum
-Online Zoological Collections of Australian Museums
-Queensland Herbarium
-National Herbarium of NSW
-Royal Botanic Gardens and National Herbarium of Victoria
-Tasmanian Herbarium
-State Herbarium of South Australia
-Northern Territory Herbarium
-Western Australian Herbarium
-Australian National Herbarium, Canberra
-University of New England
-Ocean Biogeographic Information System
-Australian Government, Department of Defence
Forestry Corporation, NSW
-Geoscience Australia
-CSIRO
-Australian Tropical Herbarium, Cairns
-eBird Australia
-Australian Government – Australian Antarctic Data Centre
-Museum and Art Gallery of the Northern Territory
-Australian Government National Environmental Science Program
-Australian Institute of Marine Science
-Reef Life Survey Australia
-American Museum of Natural History
-Queen Victoria Museum and Art Gallery, Inveresk, Tasmania
-Tasmanian Museum and Art Gallery, Hobart, Tasmania
-Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the Contact Us page.

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Appendix B

Water sampling analytical results

EMM
creating opportunities

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EB1934247**	Page	: 1 of 4
Client	: **DPM ENVIROSCIENCES**	Laboratory	: Environmental Division Brisbane
Contact	: MR DAVID MOORE	Contact	: Customer Services EB
Address	: PO BOX 1298 MOOLOOLABA QLD, AUSTRALIA 4557	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: ----	Telephone	: +61-7-3243 7222
Project	: BMA Blackwater	Date Samples Received	: 19-Dec-2019 10:15
Order number	: DPM19014	Date Analysis Commenced	: 20-Dec-2019
C-O-C number	: ----	Issue Date	: 08-Jan-2020 16:32
Sampler	: DAVID MOORE		
Site	: ----		
Quote number	: EN/333		
No. of samples received	: 6		
No. of samples analysed	: 6		

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

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

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

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

Signatories

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

Signatories	*Position*	*Accreditation Category*
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

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

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

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

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

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

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

- Sodium Adsorption Ratio (where reported): Where results for Na, Ca or Mg are <LOR, a concentration at half the reported LOR is incorporated into the SAR calculation. This represents a conservative approach for Na relative to the assumption that <LOR = zero concentration and a conservative approach for Ca & Mg relative to the assumption that <LOR is equivalent to the LOR concentration.

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	R4	R11	L1	L2	L3
				Client sampling date / time	11-Dec-2019 00:00	14-Dec-2019 00:00	10-Dec-2019 00:00	12-Dec-2019 00:00	14-Dec-2019 00:00
Compound	CAS Number	LOR	Unit		EB1934247-001	EB1934247-002	EB1934247-003	EB1934247-004	EB1934247-005
					Result	Result	Result	Result	Result
ED037P: Alkalinity by PC Titrator									
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L		<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L		<1	<1	**16**	**6**	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L		**136**	**209**	**160**	**200**	**146**
Total Alkalinity as CaCO3	----	1	mg/L		**136**	**209**	**176**	**206**	**146**
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L		**3**	<1	<1	**16**	<1
ED045G: Chloride by Discrete Analyser									
Chloride	16887-00-6	1	mg/L		**40**	**35**	**36**	**60**	**24**
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L		**32**	**43**	**20**	**42**	**21**
Magnesium	7439-95-4	1	mg/L		**13**	**20**	**11**	**20**	**12**
Sodium	7440-23-5	1	mg/L		**27**	**32**	**65**	**59**	**35**
Potassium	7440-09-7	1	mg/L		**7**	**16**	**6**	**13**	**13**
ED093F: SAR and Hardness Calculations									
Total Hardness as CaCO3	----	1	mg/L		**133**	**190**	**95**	**187**	**102**
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L		**0.2**	**0.4**	**0.9**	**0.4**	**0.3**
EN055: Ionic Balance									
ø Total Anions	----	0.01	meq/L		**3.91**	**5.16**	**4.53**	**6.14**	**3.59**
ø Total Cations	----	0.01	meq/L		**4.02**	**5.59**	**4.88**	**6.64**	**3.89**
ø Ionic Balance	----	0.01	%		**1.41**	**4.00**	**3.74**	**3.90**	**3.96**

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	L4	----	----	----	----
			Client sampling date / time	13-Dec-2019 00:00	----	----	----	----
Compound	CAS Number	LOR	Unit	EB1934247-006	--------	--------	--------	--------
				Result	----	----	----	----
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	----	----	----	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	**149**	----	----	----	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	**70**	----	----	----	----
Total Alkalinity as CaCO3	----	1	mg/L	**219**	----	----	----	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	<1	----	----	----	----
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	**88**	----	----	----	----
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	**15**	----	----	----	----
Magnesium	7439-95-4	1	mg/L	**21**	----	----	----	----
Sodium	7440-23-5	1	mg/L	**74**	----	----	----	----
Potassium	7440-09-7	1	mg/L	**62**	----	----	----	----
ED093F: SAR and Hardness Calculations								
Total Hardness as CaCO3	----	1	mg/L	**124**	----	----	----	----
EK040P: Fluoride by PC Titrator								
Fluoride	16984-48-8	0.1	mg/L	**0.6**	----	----	----	----
EN055: Ionic Balance								
ø Total Anions	----	0.01	meq/L	**6.86**	----	----	----	----
ø Total Cations	----	0.01	meq/L	**7.28**	----	----	----	----
ø Ionic Balance	----	0.01	%	**2.99**	----	----	----	----

ALS Environmental

QUALITY CONTROL REPORT

Work Order	: **EB1934247**	Page	: 1 of 4
Client	: **DPM ENVIROSCIENCES**	Laboratory	: Environmental Division Brisbane
Contact	: MR DAVID MOORE	Contact	: Customer Services EB
Address	: PO BOX 1298 MOOLOOLABA QLD, AUSTRALIA 4557	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: ----	Telephone	: +61-7-3243 7222
Project	: BMA Blackwater	Date Samples Received	: 19-Dec-2019
Order number	: DPM19014	Date Analysis Commenced	: 20-Dec-2019
C-O-C number	: ----	Issue Date	: 08-Jan-2020
Sampler	: DAVID MOORE		
Site	: ----		
Quote number	: EN/333		
No. of samples received	: 6		
No. of samples analysed	: 6		

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

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

This Quality Control Report contains the following information:

- Laboratory Duplicate (DUP) Report; Relative Percentage Difference (RPD) and Acceptance Limits
- Method Blank (MB) and Laboratory Control Spike (LCS) Report; Recovery and Acceptance Limits
- Matrix Spike (MS) Report; Recovery and Acceptance Limits

Signatories

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

Signatories	*Position*	*Accreditation Category*
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

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

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

Key : Anonymous = Refers to samples which are not specifically part of this work order but formed part of the QC process lot
CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
RPD = Relative Percentage Difference
# = Indicates failed QC

Laboratory Duplicate (DUP) Report

The quality control term Laboratory Duplicate refers to a randomly selected intralaboratory split. Laboratory duplicates provide information regarding method precision and sample heterogeneity. The permitted ranges for the Relative Percent Deviation (RPD) of Laboratory Duplicates are specified in ALS Method QWI-EN/38 and are dependent on the magnitude of results in comparison to the level of reporting: Result < 10 times LOR: No Limit; Result between 10 and 20 times LOR: 0% - 50%; Result > 20 times LOR: 0% - 20%.

Sub-Matrix: **WATER**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
ED037P: Alkalinity by PC Titrator (QC Lot: 2783840)									
EB1934205-001	Anonymous	ED037-P: Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	0.00	No Limit
		ED037-P: Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	0.00	No Limit
		ED037-P: Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	278	289	3.75	0% - 20%
		ED037-P: Total Alkalinity as CaCO3	----	1	mg/L	278	289	3.75	0% - 20%
EB1934458-002	Anonymous	ED037-P: Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	0.00	No Limit
		ED037-P: Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	0.00	No Limit
		ED037-P: Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	244	245	0.00	0% - 20%
		ED037-P: Total Alkalinity as CaCO3	----	1	mg/L	244	245	0.00	0% - 20%
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA (QC Lot: 2786741)									
EB1934247-001	R4	ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	3	3	0.00	No Limit
EB1934274-005	Anonymous	ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	238	243	2.03	0% - 20%
ED045G: Chloride by Discrete Analyser (QC Lot: 2786742)									
EB1934247-001	R4	ED045G: Chloride	16887-00-6	1	mg/L	40	38	3.63	No Limit
EB1934274-005	Anonymous	ED045G: Chloride	16887-00-6	1	mg/L	7070	7140	1.02	0% - 20%
ED093F: Dissolved Major Cations (QC Lot: 2777926)									
EB1934208-001	Anonymous	ED093F: Calcium	7440-70-2	1	mg/L	32	31	0.00	0% - 20%
		ED093F: Magnesium	7439-95-4	1	mg/L	13	13	0.00	0% - 50%
		ED093F: Sodium	7440-23-5	1	mg/L	50	51	0.00	0% - 20%
		ED093F: Potassium	7440-09-7	1	mg/L	12	11	0.00	0% - 50%
EB1934208-009	Anonymous	ED093F: Calcium	7440-70-2	1	mg/L	32	32	0.00	0% - 20%
		ED093F: Magnesium	7439-95-4	1	mg/L	13	13	0.00	0% - 50%
		ED093F: Sodium	7440-23-5	1	mg/L	48	48	0.00	0% - 20%
		ED093F: Potassium	7440-09-7	1	mg/L	11	11	0.00	0% - 50%
EK040P: Fluoride by PC Titrator (QC Lot: 2783839)									

Sub-Matrix: **WATER**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Recovery Limits (%)*
EK040P: Fluoride by PC Titrator (QC Lot: 2783839) - continued									
EB1934205-001	Anonymous	EK040P: Fluoride	16984-48-8	0.1	mg/L	0.2	0.2	0.00	No Limit
EB1934458-002	Anonymous	EK040P: Fluoride	16984-48-8	0.1	mg/L	0.1	0.1	0.00	No Limit

Method Blank (MB) and Laboratory Control Spike (LCS) Report

The quality control term Method / Laboratory Blank refers to an analyte free matrix to which all reagents are added in the same volumes or proportions as used in standard sample preparation. The purpose of this QC parameter is to monitor potential laboratory contamination. The quality control term Laboratory Control Spike (LCS) refers to a certified reference material, or a known interference free matrix spiked with target analytes. The purpose of this QC parameter is to monitor method precision and accuracy independent of sample matrix. Dynamic Recovery Limits are based on statistical evaluation of processed LCS.

Sub-Matrix: **WATER**

				Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Recovery Limits (%)	
Method: Compound	CAS Number	LOR	Unit	Result	Concentration	LCS	Low	High
ED037P: Alkalinity by PC Titrator (QCLot: 2783840)								
ED037-P: Total Alkalinity as CaCO3	----	----	mg/L	----	50 mg/L	112	80.0	120
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA (QCLot: 2786741)								
ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	<1	25 mg/L	96.3	85.0	118
				<1	100 mg/L	114	85.0	118
ED045G: Chloride by Discrete Analyser (QCLot: 2786742)								
ED045G: Chloride	16887-00-6	1	mg/L	<1	10 mg/L	102	90.0	115
				<1	1000 mg/L	100	90.0	115
ED093F: Dissolved Major Cations (QCLot: 2777926)								
ED093F: Calcium	7440-70-2	1	mg/L	<1	50 mg/L	110	70.0	130
ED093F: Magnesium	7439-95-4	1	mg/L	<1	50 mg/L	104	70.0	130
ED093F: Sodium	7440-23-5	1	mg/L	<1	50 mg/L	103	70.0	130
ED093F: Potassium	7440-09-7	1	mg/L	<1	50 mg/L	103	70.0	130
EK040P: Fluoride by PC Titrator (QCLot: 2783839)								
EK040P: Fluoride	16984-48-8	0.1	mg/L	<0.1	0.5 mg/L	96.0	80.0	117

Matrix Spike (MS) Report

The quality control term Matrix Spike (MS) refers to an intralaboratory split sample spiked with a representative set of target analytes. The purpose of this QC parameter is to monitor potential matrix effects on analyte recoveries. Static Recovery Limits as per laboratory Data Quality Objectives (DQOs). Ideal recovery ranges stated may be waived in the event of sample matrix interference.

Sub-Matrix: **WATER**

				Matrix Spike (MS) Report			
				Spike	SpikeRecovery(%)	Recovery Limits (%)	
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Concentration	MS	Low	High
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA (QCLot: 2786741)							
EB1934247-002	R11	ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	20 mg/L	102	70.0	130
ED045G: Chloride by Discrete Analyser (QCLot: 2786742)							
EB1934247-002	R11	ED045G: Chloride	16887-00-6	400 mg/L	109	70.0	130
EK040P: Fluoride by PC Titrator (QCLot: 2783839)							
EB1934205-002	Anonymous	EK040P: Fluoride	16984-48-8	5 mg/L	75.2	70.0	130

ALS Environmental

QA/QC Compliance Assessment to assist with Quality Review

Work Order	: **EB1934247**	Page	: 1 of 5
Client	: **DPM ENVIROSCIENCES**	Laboratory	: Environmental Division Brisbane
Contact	: MR DAVID MOORE	Telephone	: +61-7-3243 7222
Project	: BMA Blackwater	Date Samples Received	: 19-Dec-2019
Site	: ----	Issue Date	: 08-Jan-2020
Sampler	: DAVID MOORE	No. of samples received	: 6
Order number	: DPM19014	No. of samples analysed	: 6

This report is automatically generated by the ALS LIMS through interpretation of the ALS Quality Control Report and several Quality Assurance parameters measured by ALS. This automated reporting highlights any non-conformances, facilitates faster and more accurate data validation and is designed to assist internal expert and external Auditor review. Many components of this report contribute to the overall DQO assessment and reporting for guideline compliance.

Brief method summaries and references are also provided to assist in traceability.

Summary of Outliers

Outliers : Quality Control Samples

This report highlights outliers flagged in the Quality Control (QC) Report.

- **NO Method Blank value outliers occur.**
- **NO Duplicate outliers occur.**
- **NO Laboratory Control outliers occur.**
- **NO Matrix Spike outliers occur.**
- **For all regular sample matrices, NO surrogate recovery outliers occur.**

Outliers : Analysis Holding Time Compliance

- **NO Analysis Holding Time Outliers exist.**

Outliers : Frequency of Quality Control Samples

- **NO Quality Control Sample Frequency Outliers exist.**

Analysis Holding Time Compliance

If samples are identified below as having been analysed or extracted outside of recommended holding times, this should be taken into consideration when interpreting results.

This report summarizes extraction / preparation and analysis times and compares each with ALS recommended holding times (referencing USEPA SW 846, APHA, AS and NEPM) based on the sample container provided. Dates reported represent first date of extraction or analysis and preclude subsequent dilutions and reruns. A listing of breaches (if any) is provided herein.

Holding time for leachate methods (e.g. TCLP) vary according to the analytes reported. Assessment compares the leach date with the shortest analyte holding time for the equivalent soil method. These are: organics 14 days, mercury 28 days & other metals 180 days. A recorded breach does not guarantee a breach for all non-volatile parameters.

Holding times for ***VOC in soils*** vary according to analytes of interest. Vinyl Chloride and Styrene holding time is 7 days; others 14 days. A recorded breach does not guarantee a breach for all VOC analytes and should be verified in case the reported breach is a false positive or Vinyl Chloride and Styrene are not key analytes of interest/concern.

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
ED037P: Alkalinity by PC Titrator							
Clear Plastic Bottle - Natural (ED037-P) L1	**10-Dec-2019**	**----**	----	----	**24-Dec-2019**	24-Dec-2019	✓
Clear Plastic Bottle - Natural (ED037-P) R4	**11-Dec-2019**	**----**	----	----	**24-Dec-2019**	25-Dec-2019	✓
Clear Plastic Bottle - Natural (ED037-P) L2	**12-Dec-2019**	**----**	----	----	**24-Dec-2019**	26-Dec-2019	✓
Clear Plastic Bottle - Natural (ED037-P) L4	**13-Dec-2019**	**----**	----	----	**24-Dec-2019**	27-Dec-2019	✓
Clear Plastic Bottle - Natural (ED037-P) R11, L3	**14-Dec-2019**	**----**	----	----	**24-Dec-2019**	28-Dec-2019	✓
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA							
Clear Plastic Bottle - Natural (ED041G) L1	**10-Dec-2019**	**----**	----	----	**27-Dec-2019**	07-Jan-2020	✓
Clear Plastic Bottle - Natural (ED041G) R4	**11-Dec-2019**	**----**	----	----	**27-Dec-2019**	08-Jan-2020	✓
Clear Plastic Bottle - Natural (ED041G) L2	**12-Dec-2019**	**----**	----	----	**27-Dec-2019**	09-Jan-2020	✓
Clear Plastic Bottle - Natural (ED041G) L4	**13-Dec-2019**	**----**	----	----	**27-Dec-2019**	10-Jan-2020	✓
Clear Plastic Bottle - Natural (ED041G) R11, L3	**14-Dec-2019**	**----**	----	----	**27-Dec-2019**	11-Jan-2020	✓
ED045G: Chloride by Discrete Analyser							
Clear Plastic Bottle - Natural (ED045G) L1	**10-Dec-2019**	**----**	----	----	**27-Dec-2019**	07-Jan-2020	✓
Clear Plastic Bottle - Natural (ED045G) R4	**11-Dec-2019**	**----**	----	----	**27-Dec-2019**	08-Jan-2020	✓
Clear Plastic Bottle - Natural (ED045G) L2	**12-Dec-2019**	**----**	----	----	**27-Dec-2019**	09-Jan-2020	✓
Clear Plastic Bottle - Natural (ED045G) L4	**13-Dec-2019**	**----**	----	----	**27-Dec-2019**	10-Jan-2020	✓
Clear Plastic Bottle - Natural (ED045G) R11, L3	**14-Dec-2019**	**----**	----	----	**27-Dec-2019**	11-Jan-2020	✓

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
ED093F: Dissolved Major Cations							
Clear Plastic Bottle - Nitric Acid; Filtered (ED093F) L1	**10-Dec-2019**	**----**	----	----	**20-Dec-2019**	07-Jan-2020	✓
Clear Plastic Bottle - Nitric Acid; Filtered (ED093F) R4	**11-Dec-2019**	**----**	----	----	**20-Dec-2019**	08-Jan-2020	✓
Clear Plastic Bottle - Nitric Acid; Filtered (ED093F) L2	**12-Dec-2019**	**----**	----	----	**20-Dec-2019**	09-Jan-2020	✓
Clear Plastic Bottle - Nitric Acid; Filtered (ED093F) L4	**13-Dec-2019**	**----**	----	----	**20-Dec-2019**	10-Jan-2020	✓
Clear Plastic Bottle - Nitric Acid; Filtered (ED093F) R11, L3	**14-Dec-2019**	**----**	----	----	**20-Dec-2019**	11-Jan-2020	✓
ED093F: SAR and Hardness Calculations							
Clear Plastic Bottle - Nitric Acid; Filtered (ED093F) L1	**10-Dec-2019**	**----**	----	----	**20-Dec-2019**	07-Jan-2020	✓
Clear Plastic Bottle - Nitric Acid; Filtered (ED093F) R4	**11-Dec-2019**	**----**	----	----	**20-Dec-2019**	08-Jan-2020	✓
Clear Plastic Bottle - Nitric Acid; Filtered (ED093F) L2	**12-Dec-2019**	**----**	----	----	**20-Dec-2019**	09-Jan-2020	✓
Clear Plastic Bottle - Nitric Acid; Filtered (ED093F) L4	**13-Dec-2019**	**----**	----	----	**20-Dec-2019**	10-Jan-2020	✓
Clear Plastic Bottle - Nitric Acid; Filtered (ED093F) R11, L3	**14-Dec-2019**	**----**	----	----	**20-Dec-2019**	11-Jan-2020	✓
EK040P: Fluoride by PC Titrator							
Clear Plastic Bottle - Natural (EK040P) L1	**10-Dec-2019**	**----**	----	----	**24-Dec-2019**	07-Jan-2020	✓
Clear Plastic Bottle - Natural (EK040P) R4	**11-Dec-2019**	**----**	----	----	**24-Dec-2019**	08-Jan-2020	✓
Clear Plastic Bottle - Natural (EK040P) L2	**12-Dec-2019**	**----**	----	----	**24-Dec-2019**	09-Jan-2020	✓
Clear Plastic Bottle - Natural (EK040P) L4	**13-Dec-2019**	**----**	----	----	**24-Dec-2019**	10-Jan-2020	✓
Clear Plastic Bottle - Natural (EK040P) R11, L3	**14-Dec-2019**	**----**	----	----	**24-Dec-2019**	11-Jan-2020	✓

Quality Control Parameter Frequency Compliance

The following report summarises the frequency of laboratory QC samples analysed within the analytical lot(s) in which the submitted sample(s) was(were) processed. Actual rate should be greater than or equal to the expected rate. A listing of breaches is provided in the Summary of Outliers.

Matrix: **WATER**

Evaluation: × = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Laboratory Duplicates (DUP)							
Alkalinity by PC Titrator	ED037-P	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Fluoride by PC Titrator	EK040P	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Major Cations - Dissolved	ED093F	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Laboratory Control Samples (LCS)							
Alkalinity by PC Titrator	ED037-P	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Fluoride by PC Titrator	EK040P	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Major Cations - Dissolved	ED093F	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Method Blanks (MB)							
Chloride by Discrete Analyser	ED045G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Fluoride by PC Titrator	EK040P	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Major Cations - Dissolved	ED093F	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Matrix Spikes (MS)							
Chloride by Discrete Analyser	ED045G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Fluoride by PC Titrator	EK040P	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard

Brief Method Summaries

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the US EPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request. The following report provides brief descriptions of the analytical procedures employed for results reported in the Certificate of Analysis. Sources from which ALS methods have been developed are provided within the Method Descriptions.

Analytical Methods	Method	Matrix	Method Descriptions
Alkalinity by PC Titrator	ED037-P	WATER	In house: Referenced to APHA 2320 B This procedure determines alkalinity by automated measurement (e.g. PC Titrate) using pH 4.5 for indicating the total alkalinity end-point. This method is compliant with NEPM (2013) Schedule B(3)
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	WATER	In house: Referenced to APHA 4500-SO4. Dissolved sulfate is determined in a 0.45um filtered sample. Sulfate ions are converted to a barium sulfate suspension in an acetic acid medium with barium chloride. Light absorbance of the BaSO4 suspension is measured by a photometer and the SO4-2 concentration is determined by comparison of the reading with a standard curve. This method is compliant with NEPM (2013) Schedule B(3)
Chloride by Discrete Analyser	ED045G	WATER	In house: Referenced to APHA 4500 Cl - G.The thiocyanate ion is liberated from mercuric thiocyanate through sequestration of mercury by the chloride ion to form non-ionised mercuric chloride.in the presence of ferric ions the librated thiocynate forms highly-coloured ferric thiocynate which is measured at 480 nm APHA 21st edition seal method 2 017-1-L april 2003
Major Cations - Dissolved	ED093F	WATER	In house: Referenced to APHA 3120 and 3125; USEPA SW 846 - 6010 and 6020; Cations are determined by either ICP-AES or ICP-MS techniques. This method is compliant with NEPM (2013) Schedule B(3) Sodium Adsorption Ratio is calculated from Ca, Mg and Na which determined by ALS in house method QWI-EN/ED093F. This method is compliant with NEPM (2013) Schedule B(3) Hardness parameters are calculated based on APHA 2340 B. This method is compliant with NEPM (2013) Schedule B(3)
Fluoride by PC Titrator	EK040P	WATER	In house: Referenced to APHA 4500-F C: CDTA is added to the sample to provide a uniform ionic strength background, adjust pH, and break up complexes. Fluoride concentration is determined by either manual or automatic ISE measurement. This method is compliant with NEPM (2013) Schedule B(3)
Ionic Balance by PCT DA and Turbi SO4 DA	* EN055 - PG	WATER	In house: Referenced to APHA 1030F. This method is compliant with NEPM (2013) Schedule B(3)

8|1

CHAIN OF CUSTODY

ALS Laboratory: please tick →

☐ADELAIDE 3/1 Burma Road Pooraka SA 5095 Ph: 08 8162 5130 E: adelaide@alsglobal.com

☐BRISBANE 2 Byth Street Stafford QLD 4053 Ph: 07 3243 7222 E: samples.brisbane@alsglobal.com

☐GLADSTONE 48 Callemondah Drive Gladstone QLD 4680 Ph: 07 4978 7944 E: gladstone@alsglobal.com

☐MACKAY 78 Harbour Road Mackay QLD 4740 Ph: 07 4944 0177 E: mackay@alsglobal.com

☐MELBOURNE 2-4 Westall Road Springvale VIC 3171 Ph: 03 8549 9600 E: samples.melbourne@alsglobal.com

☐MUDGEE 1/29 Sydney Road Mudgee NSW 2850 Ph: 02 6372 6735 E: mudgee.mail@alsglobal.com

☐NEWCASTLE 5/585 Maitland Road Mayfield West NSW 2304 Ph: 02 4014 2500 E: samples.newcastle@alsglobal.com

☐NOWRA 4/13 Geary Place North Nowra NSW 2541 Ph. 02 4423 2063 E: nowra@alsglobal.com

☐PERTH 10 Hod Way Malaga WA 6090 Ph: 08 9209 7655 E: samples.perth@alsglobal.com

☐SYDNEY 277-289 Woodpark Road Smithfield NSW 2164 Ph: 02 8784 8555 E: samples.sydney@alsglobal.com

☐TOWNSVILLE 14-15 Desma Court Bohle QLD 4818 Ph: 07 4796 0600 E: townsville.environmental@alsglobal.com

☐WOLLONGONG 1/19-21 Ralph Black Drive, Nth Wollongong NSW 2500 Ph: 02 4225 3125 E: wollongong@alsglobal.com

CLIENT: DPM Envirosciences Pty Ltd

OFFICE: 12 Lauren Drive, BUDERIM QLD 4556

PROJECT: Glencore Valeria — **PROJECT NO** DPM19014

ORDER NUMBER: — **PURCHASE ORDER NO.:**

PROJECT MANAGER: David Moore — **CONTACT PH:** 0427 694 433

SAMPLER: David Moore — **SAMPLER MOBILE:** 0427 694 433

COC Emailed to ALS? (YES / NO) — **EDD FORMAT (or default):**

Email Reports to (will default to PM if no other addresses are listed): dmoore@dpm-enviro.com.au

Email Invoice to (will default to PM if no other addresses are listed): dmoore@dpm-enviro.com.au

TURNAROUND REQUIREMENTS : (Standard TAT may be longer for some tests e.g.. Ultra Trace Organics)

☒ Standard TAT **(List due date):**

☐ Non Standard or urgent TAT **(List due date):**

ALS QUOTE NO.:

COUNTRY OF ORIGIN: Australia

COC SEQUENCE NUMBER (Circle)

COC: 1 2 3 4 5 6 7

OF: 1 2 3 4 5 6 7

FOR LABORATORY USE ONLY (Circle)

Custody Seal intact?	Yes	No	N/A
Free ice / frozen ice bricks present upon receipt?	Yes	No	N/A
Random Sample Temperature on Receipt:		°C	
Other comment:			

RELINQUISHED BY:	RECEIVED BY:	RELINQUISHED BY:	RECEIVED BY:
David Moore	DM		
DATE/TIME: 19/12/19 10:15	DATE/TIME: 19/12/19 10:15	DATE/TIME:	DATE/TIME:

COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:

ALS USE ONLY	SAMPLE DETAILS MATRIX: Solid(S) Water(W)			CONTAINER INFORMATION									Additional Information
LAB ID	SAMPLE ID	DATE / TIME	MATRIX	TYPE & PRESERVATIVE (refer to codes below)	TOTAL BOTTLES	NT-1D (Major cations [Ca, Mg, Na, K] + Hardness)	NT-2A (Major anions [Cl, SO4, F, Alkalinity)						Comments on likely contaminant levels, dilutions, or samples requiring specific QC analysis etc.
1	R4	11/12/2019	W	P, N	2	✓	✓						
2	R11	14/12/2019	W	P, N	2	✓	✓						
3	L1	10/12/2019	W	P, N	2	✓	✓						
4	L2	12/12/2019	W	P, N	2	✓	✓						
5	L3	14/12/2019	W	P, N	2	✓	✓						
6	L4	13/12/2019	W	P, N	2	✓	✓						
				TOTAL	12								

Environmental Division
Brisbane
Work Order Reference
EB1934247

Telephone : + 61-7-3243 7222

Water Container Codes: P = Unpreserved Plastic; N = Nitric Preserved Plastic; ORC = Nitric Preserved ORC; SH = Sodium Hydroxide/Cd Preserved; S = Sodium Hydroxide Preserved Plastic; AG = Amber Glass Unpreserved; AP - Airfreight Unpreserved Plastic
V = VOA Vial HCl Preserved; VB = VOA Vial Sodium Bisulphate Preserved; VS = VOA Vial Sulfuric Preserved; AV = Airfreight Unpreserved Vial SG = Sulfuric Preserved Amber Glass; H = HCl preserved Plastic; HS = HCl preserved Speciation bottle; SP = Sulfuric Preserved Plastic; F = Formaldehyde Preserved Glass;
Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; ASS = Plastic Bag for Acid Sulphate Soils; B = Unpreserved Bag; LI = Lugols Iodine Preserved Bottles; STT = Sterile Sodium Thiosulfate Preserved Bottles.

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EB2014980**	Page	: 1 of 4
Client	: **DPM ENVIROSCIENCES**	Laboratory	: Environmental Division Brisbane
Contact	: MR DAVID MOORE	Contact	: Customer Services EB
Address	: PO BOX 1298 MOOLOOLABA QLD, AUSTRALIA 4557	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: ----	Telephone	: +61-7-3243 7222
Project	: DPM19014 BMA Blackwater	Date Samples Received	: 05-Jun-2020 10:30
Order number	: ----	Date Analysis Commenced	: 05-Jun-2020
C-O-C number	: ----	Issue Date	: 11-Jun-2020 09:51
Sampler	: DAVID MOORE		
Site	: ----		
Quote number	: EN/333		
No. of samples received	: 10		
No. of samples analysed	: 10		

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

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

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

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

Signatories

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

Signatories	*Position*	*Accreditation Category*
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD

General Comments

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

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

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

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

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

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

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

- Sodium Adsorption Ratio (where reported): Where results for Na, Ca or Mg are <LOR, a concentration at half the reported LOR is incorporated into the SAR calculation. This represents a conservative approach for Na relative to the assumption that <LOR = zero concentration and a conservative approach for Ca & Mg relative to the assumption that <LOR is equivalent to the LOR concentration.

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	L1	R4	L2	RW1	L3
				Client sampling date / time	19-May-2020 00:00	20-May-2020 00:00	21-May-2020 00:00	21-May-2020 00:00	25-May-2020 00:00
Compound	CAS Number	LOR	Unit		EB2014980-001	EB2014980-002	EB2014980-003	EB2014980-004	EB2014980-005
					Result	Result	Result	Result	Result
ED037P: Alkalinity by PC Titrator									
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L		<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L		<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L		194	282	298	123	105
Total Alkalinity as CaCO3	----	1	mg/L		194	282	298	123	105
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L		<1	14	643	62	<1
ED045G: Chloride by Discrete Analyser									
Chloride	16887-00-6	1	mg/L		23	51	248	68	13
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L		34	51	132	27	15
Magnesium	7439-95-4	1	mg/L		12	16	74	12	8
Sodium	7440-23-5	1	mg/L		34	68	286	67	20
Potassium	7440-09-7	1	mg/L		7	8	16	7	9
ED093F: SAR and Hardness Calculations									
Total Hardness as CaCO3	----	1	mg/L		134	193	634	117	70
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L		0.5	0.4	0.3	0.4	0.2
EN055: Ionic Balance									
ø Total Anions	----	0.01	meq/L		4.52	7.36	26.3	5.67	2.46
ø Total Cations	----	0.01	meq/L		4.34	7.02	25.5	5.43	2.51
ø Ionic Balance	----	0.01	%		2.06	2.36	1.56	2.15	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	R9	R11	P1	R12	L4
				Client sampling date / time	25-May-2020 00:00	26-May-2020 00:00	27-May-2020 00:00	27-May-2020 00:00	28-May-2020 00:00
Compound	CAS Number	LOR	Unit		EB2014980-006	EB2014980-007	EB2014980-008	EB2014980-009	EB2014980-010
					Result	Result	Result	Result	Result
ED037P: Alkalinity by PC Titrator									
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L		<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L		<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L		**100**	**98**	**82**	**134**	**96**
Total Alkalinity as CaCO3	----	1	mg/L		**100**	**98**	**82**	**134**	**96**
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L		**2**	**3**	<1	**4**	<1
ED045G: Chloride by Discrete Analyser									
Chloride	16887-00-6	1	mg/L		**17**	**11**	**2**	**26**	**15**
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L		**17**	**18**	**22**	**25**	**14**
Magnesium	7439-95-4	1	mg/L		**7**	**7**	**3**	**12**	**8**
Sodium	7440-23-5	1	mg/L		**16**	**15**	**2**	**23**	**10**
Potassium	7440-09-7	1	mg/L		**8**	**7**	**10**	**7**	**17**
ED093F: SAR and Hardness Calculations									
Total Hardness as CaCO3	----	1	mg/L		**71**	**74**	**67**	**112**	**68**
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L		**0.2**	**0.3**	<0.1	**0.3**	**0.2**
EN055: Ionic Balance									
ø Total Anions	----	0.01	meq/L		**2.52**	**2.33**	**1.69**	**3.49**	**2.34**
ø Total Cations	----	0.01	meq/L		**2.32**	**2.30**	**1.69**	**3.41**	**2.23**
ø Ionic Balance	----	0.01	%		**----**	**----**	**----**	**1.15**	**----**

ALS Environmental

QUALITY CONTROL REPORT

Work Order	: **EB2014980**	Page	: 1 of 4
Client	: **DPM ENVIROSCIENCES**	Laboratory	: Environmental Division Brisbane
Contact	: MR DAVID MOORE	Contact	: Customer Services EB
Address	: PO BOX 1298 MOOLOOLABA QLD, AUSTRALIA 4557	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: ----	Telephone	: +61-7-3243 7222
Project	: DPM19014 BMA Blackwater	Date Samples Received	: 05-Jun-2020
Order number	: ----	Date Analysis Commenced	: 05-Jun-2020
C-O-C number	: ----	Issue Date	: 11-Jun-2020
Sampler	: DAVID MOORE		
Site	: ----		
Quote number	: EN/333		
No. of samples received	: 10		
No. of samples analysed	: 10		

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

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

This Quality Control Report contains the following information:

- Laboratory Duplicate (DUP) Report; Relative Percentage Difference (RPD) and Acceptance Limits
- Method Blank (MB) and Laboratory Control Spike (LCS) Report; Recovery and Acceptance Limits
- Matrix Spike (MS) Report; Recovery and Acceptance Limits

Signatories

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

Signatories	*Position*	*Accreditation Category*
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD

General Comments

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

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

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

Key : Anonymous = Refers to samples which are not specifically part of this work order but formed part of the QC process lot
CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
RPD = Relative Percentage Difference
# = Indicates failed QC

Laboratory Duplicate (DUP) Report

The quality control term Laboratory Duplicate refers to a randomly selected intralaboratory split. Laboratory duplicates provide information regarding method precision and sample heterogeneity. The permitted ranges for the Relative Percent Deviation (RPD) of Laboratory Duplicates are specified in ALS Method QWI-EN/38 and are dependent on the magnitude of results in comparison to the level of reporting: Result < 10 times LOR: No Limit; Result between 10 and 20 times LOR: 0% - 50%; Result > 20 times LOR: 0% - 20%.

Sub-Matrix: **WATER**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Recovery Limits (%)*
ED037P: Alkalinity by PC Titrator (QC Lot: 3062842)									
EB2014805-001	Anonymous	ED037-P: Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	0.00	No Limit
		ED037-P: Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	0.00	No Limit
		ED037-P: Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	235	233	0.573	0% - 20%
		ED037-P: Total Alkalinity as CaCO3	----	1	mg/L	235	233	0.573	0% - 20%
EB2014916-006	Anonymous	ED037-P: Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	0.00	No Limit
		ED037-P: Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	407	409	0.559	0% - 20%
		ED037-P: Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	123	119	3.41	0% - 20%
		ED037-P: Total Alkalinity as CaCO3	----	1	mg/L	530	528	0.353	0% - 20%
ED037P: Alkalinity by PC Titrator (QC Lot: 3062844)									
EB2014980-005	L3	ED037-P: Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	0.00	No Limit
		ED037-P: Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	0.00	No Limit
		ED037-P: Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	105	103	1.85	0% - 20%
		ED037-P: Total Alkalinity as CaCO3	----	1	mg/L	105	103	1.85	0% - 20%
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA (QC Lot: 3068547)									
EB2014980-001	L1	ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	<1	<1	0.00	No Limit
EB2015067-016	Anonymous	ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	10	10	0.00	0% - 50%
ED045G: Chloride by Discrete Analyser (QC Lot: 3068548)									
EB2014980-001	L1	ED045G: Chloride	16887-00-6	1	mg/L	23	23	0.00	0% - 20%
EB2015067-016	Anonymous	ED045G: Chloride	16887-00-6	1	mg/L	66	65	0.00	0% - 20%
ED093F: Dissolved Major Cations (QC Lot: 3064351)									
EB2014890-001	Anonymous	ED093F: Calcium	7440-70-2	1	mg/L	<1	<1	0.00	No Limit
		ED093F: Magnesium	7439-95-4	1	mg/L	<1	<1	0.00	No Limit
		ED093F: Sodium	7440-23-5	1	mg/L	347	347	0.00	0% - 20%
		ED093F: Potassium	7440-09-7	1	mg/L	2	2	0.00	No Limit

Sub-Matrix: **WATER**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Recovery Limits (%)*
ED093F: Dissolved Major Cations (QC Lot: 3064351) - continued									
EB2014980-005	L3	ED093F: Calcium	7440-70-2	1	mg/L	15	14	0.00	0% - 50%
		ED093F: Magnesium	7439-95-4	1	mg/L	8	7	0.00	No Limit
		ED093F: Sodium	7440-23-5	1	mg/L	20	20	0.00	0% - 20%
		ED093F: Potassium	7440-09-7	1	mg/L	9	9	0.00	No Limit
EK040P: Fluoride by PC Titrator (QC Lot: 3062843)									
EB2014980-001	L1	EK040P: Fluoride	16984-48-8	0.1	mg/L	0.5	0.5	0.00	No Limit

Method Blank (MB) and Laboratory Control Spike (LCS) Report

The quality control term Method / Laboratory Blank refers to an analyte free matrix to which all reagents are added in the same volumes or proportions as used in standard sample preparation. The purpose of this QC parameter is to monitor potential laboratory contamination. The quality control term Laboratory Control Spike (LCS) refers to a certified reference material, or a known interference free matrix spiked with target analytes. The purpose of this QC parameter is to monitor method precision and accuracy independent of sample matrix. Dynamic Recovery Limits are based on statistical evaluation of processed LCS.

Sub-Matrix: **WATER**

				Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Recovery Limits (%)	
Method: Compound	CAS Number	LOR	Unit	Result	Concentration	LCS	Low	High
ED037P: Alkalinity by PC Titrator (QCLot: 3062842)								
ED037-P: Total Alkalinity as CaCO3	----	----	mg/L	----	50 mg/L	110	80.0	120
ED037P: Alkalinity by PC Titrator (QCLot: 3062844)								
ED037-P: Total Alkalinity as CaCO3	----	----	mg/L	----	200 mg/L	102	80.0	120
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA (QCLot: 3068547)								
ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	<1	25 mg/L	106	85.0	118
				<1	100 mg/L	103	85.0	118
ED045G: Chloride by Discrete Analyser (QCLot: 3068548)								
ED045G: Chloride	16887-00-6	1	mg/L	<1	10 mg/L	93.4	90.0	115
				<1	1000 mg/L	103	90.0	115
ED093F: Dissolved Major Cations (QCLot: 3064351)								
ED093F: Calcium	7440-70-2	1	mg/L	<1	50 mg/L	94.8	70.0	130
ED093F: Magnesium	7439-95-4	1	mg/L	<1	50 mg/L	96.9	70.0	130
ED093F: Sodium	7440-23-5	1	mg/L	<1	50 mg/L	98.2	70.0	130
ED093F: Potassium	7440-09-7	1	mg/L	<1	50 mg/L	97.7	70.0	130
EK040P: Fluoride by PC Titrator (QCLot: 3062843)								
EK040P: Fluoride	16984-48-8	0.1	mg/L	<0.1	0.5 mg/L	100	80.0	117

Matrix Spike (MS) Report

The quality control term Matrix Spike (MS) refers to an intralaboratory split sample spiked with a representative set of target analytes. The purpose of this QC parameter is to monitor potential matrix effects on analyte recoveries. Static Recovery Limits as per laboratory Data Quality Objectives (DQOs). Ideal recovery ranges stated may be waived in the event of sample matrix interference.

Sub-Matrix: **WATER**

				Matrix Spike (MS) Report			
				Spike	SpikeRecovery(%)	Recovery Limits (%)	
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Concentration	MS	Low	High
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA (QCLot: 3068547)							
EB2014980-002	R4	ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	20 mg/L	96.2	70.0	130
ED045G: Chloride by Discrete Analyser (QCLot: 3068548)							
EB2014980-002	R4	ED045G: Chloride	16887-00-6	400 mg/L	108	70.0	130
EK040P: Fluoride by PC Titrator (QCLot: 3062843)							
EB2014980-002	R4	EK040P: Fluoride	16984-48-8	5 mg/L	95.6	70.0	130

ALS Environmental

QA/QC Compliance Assessment to assist with Quality Review

Work Order	: **EB2014980**	Page	: 1 of 6
Client	: **DPM ENVIROSCIENCES**	Laboratory	: Environmental Division Brisbane
Contact	: MR DAVID MOORE	Telephone	: +61-7-3243 7222
Project	: DPM19014 BMA Blackwater	Date Samples Received	: 05-Jun-2020
Site	: ----	Issue Date	: 11-Jun-2020
Sampler	: DAVID MOORE	No. of samples received	: 10
Order number	: ----	No. of samples analysed	: 10

This report is automatically generated by the ALS LIMS through interpretation of the ALS Quality Control Report and several Quality Assurance parameters measured by ALS. This automated reporting highlights any non-conformances, facilitates faster and more accurate data validation and is designed to assist internal expert and external Auditor review. Many components of this report contribute to the overall DQO assessment and reporting for guideline compliance.

Brief method summaries and references are also provided to assist in traceability.

Summary of Outliers

Outliers : Quality Control Samples

This report highlights outliers flagged in the Quality Control (QC) Report.

- **NO Method Blank value outliers occur.**
- **NO Duplicate outliers occur.**
- **NO Laboratory Control outliers occur.**
- **NO Matrix Spike outliers occur.**
- **For all regular sample matrices, NO surrogate recovery outliers occur.**

Outliers : Analysis Holding Time Compliance

- **Analysis Holding Time Outliers exist - please see following pages for full details.**

Outliers : Frequency of Quality Control Samples

- **NO Quality Control Sample Frequency Outliers exist.**

Outliers : Analysis Holding Time Compliance

Matrix: **WATER**

Method / Container / Client Sample ID(s)	Extraction / Preparation			Analysis		
	Date extracted	Due for extraction	Days overdue	Date analysed	Due for analysis	Days overdue
ED037P: Alkalinity by PC Titrator						
Clear Plastic Bottle - Natural L1	----	----	----	05-Jun-2020	02-Jun-2020	**3**
Clear Plastic Bottle - Natural R4	----	----	----	05-Jun-2020	03-Jun-2020	**2**
Clear Plastic Bottle - Natural L2, RW1	----	----	----	05-Jun-2020	04-Jun-2020	**1**

Analysis Holding Time Compliance

If samples are identified below as having been analysed or extracted outside of recommended holding times, this should be taken into consideration when interpreting results.

This report summarizes extraction / preparation and analysis times and compares each with ALS recommended holding times (referencing USEPA SW 846, APHA, AS and NEPM) based on the sample container provided. Dates reported represent first date of extraction or analysis and preclude subsequent dilutions and reruns. A listing of breaches (if any) is provided herein.

Holding time for leachate methods (e.g. TCLP) vary according to the analytes reported. Assessment compares the leach date with the shortest analyte holding time for the equivalent soil method. These are: organics 14 days, mercury 28 days & other metals 180 days. A recorded breach does not guarantee a breach for all non-volatile parameters.

Holding times for ***VOC in soils*** vary according to analytes of interest. Vinyl Chloride and Styrene holding time is 7 days; others 14 days. A recorded breach does not guarantee a breach for all VOC analytes and should be verified in case the reported breach is a false positive or Vinyl Chloride and Styrene are not key analytes of interest/concern.

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
ED037P: Alkalinity by PC Titrator							
Clear Plastic Bottle - Natural (ED037-P) L1	**19-May-2020**	**----**	----	----	**05-Jun-2020**	02-Jun-2020	×
Clear Plastic Bottle - Natural (ED037-P) R4	**20-May-2020**	**----**	----	----	**05-Jun-2020**	03-Jun-2020	×
Clear Plastic Bottle - Natural (ED037-P) L2, RW1	**21-May-2020**	**----**	----	----	**05-Jun-2020**	04-Jun-2020	×
Clear Plastic Bottle - Natural (ED037-P) L3, R9	**25-May-2020**	**----**	----	----	**05-Jun-2020**	08-Jun-2020	✓
Clear Plastic Bottle - Natural (ED037-P) R11	**26-May-2020**	**----**	----	----	**05-Jun-2020**	09-Jun-2020	✓
Clear Plastic Bottle - Natural (ED037-P) P1, R12	**27-May-2020**	**----**	----	----	**05-Jun-2020**	10-Jun-2020	✓
Clear Plastic Bottle - Natural (ED037-P) L4	**28-May-2020**	**----**	----	----	**05-Jun-2020**	11-Jun-2020	✓

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA							
Clear Plastic Bottle - Natural (ED041G) L1	**19-May-2020**	**----**	----	----	**09-Jun-2020**	16-Jun-2020	✓
Clear Plastic Bottle - Natural (ED041G) R4	**20-May-2020**	**----**	----	----	**09-Jun-2020**	17-Jun-2020	✓
Clear Plastic Bottle - Natural (ED041G) L2, RW1	**21-May-2020**	**----**	----	----	**09-Jun-2020**	18-Jun-2020	✓
Clear Plastic Bottle - Natural (ED041G) L3, R9	**25-May-2020**	**----**	----	----	**09-Jun-2020**	22-Jun-2020	✓
Clear Plastic Bottle - Natural (ED041G) R11	**26-May-2020**	**----**	----	----	**09-Jun-2020**	23-Jun-2020	✓
Clear Plastic Bottle - Natural (ED041G) P1, R12	**27-May-2020**	**----**	----	----	**09-Jun-2020**	24-Jun-2020	✓
Clear Plastic Bottle - Natural (ED041G) L4	**28-May-2020**	**----**	----	----	**09-Jun-2020**	25-Jun-2020	✓
ED045G: Chloride by Discrete Analyser							
Clear Plastic Bottle - Natural (ED045G) L1	**19-May-2020**	**----**	----	----	**09-Jun-2020**	16-Jun-2020	✓
Clear Plastic Bottle - Natural (ED045G) R4	**20-May-2020**	**----**	----	----	**09-Jun-2020**	17-Jun-2020	✓
Clear Plastic Bottle - Natural (ED045G) L2, RW1	**21-May-2020**	**----**	----	----	**09-Jun-2020**	18-Jun-2020	✓
Clear Plastic Bottle - Natural (ED045G) L3, R9	**25-May-2020**	**----**	----	----	**09-Jun-2020**	22-Jun-2020	✓
Clear Plastic Bottle - Natural (ED045G) R11	**26-May-2020**	**----**	----	----	**09-Jun-2020**	23-Jun-2020	✓
Clear Plastic Bottle - Natural (ED045G) P1, R12	**27-May-2020**	**----**	----	----	**09-Jun-2020**	24-Jun-2020	✓
Clear Plastic Bottle - Natural (ED045G) L4	**28-May-2020**	**----**	----	----	**09-Jun-2020**	25-Jun-2020	✓
ED093F: Dissolved Major Cations							
Clear Plastic Bottle - Nitric Acid; Filtered (ED093F) L1	**19-May-2020**	**----**	----	----	**10-Jun-2020**	16-Jun-2020	✓
Clear Plastic Bottle - Nitric Acid; Filtered (ED093F) R4	**20-May-2020**	**----**	----	----	**10-Jun-2020**	17-Jun-2020	✓
Clear Plastic Bottle - Nitric Acid; Filtered (ED093F) L2, RW1	**21-May-2020**	**----**	----	----	**10-Jun-2020**	18-Jun-2020	✓
Clear Plastic Bottle - Nitric Acid; Filtered (ED093F) L3, R9	**25-May-2020**	**----**	----	----	**10-Jun-2020**	22-Jun-2020	✓
Clear Plastic Bottle - Nitric Acid; Filtered (ED093F) R11	**26-May-2020**	**----**	----	----	**10-Jun-2020**	23-Jun-2020	✓
Clear Plastic Bottle - Nitric Acid; Filtered (ED093F) P1, R12	**27-May-2020**	**----**	----	----	**10-Jun-2020**	24-Jun-2020	✓
Clear Plastic Bottle - Nitric Acid; Filtered (ED093F) L4	**28-May-2020**	**----**	----	----	**10-Jun-2020**	25-Jun-2020	✓

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
ED093F: SAR and Hardness Calculations							
Clear Plastic Bottle - Nitric Acid; Filtered (ED093F) L1	**19-May-2020**	**----**	----	----	**10-Jun-2020**	16-Jun-2020	✓
Clear Plastic Bottle - Nitric Acid; Filtered (ED093F) R4	**20-May-2020**	**----**	----	----	**10-Jun-2020**	17-Jun-2020	✓
Clear Plastic Bottle - Nitric Acid; Filtered (ED093F) L2, RW1	**21-May-2020**	**----**	----	----	**10-Jun-2020**	18-Jun-2020	✓
Clear Plastic Bottle - Nitric Acid; Filtered (ED093F) L3, R9	**25-May-2020**	**----**	----	----	**10-Jun-2020**	22-Jun-2020	✓
Clear Plastic Bottle - Nitric Acid; Filtered (ED093F) R11	**26-May-2020**	**----**	----	----	**10-Jun-2020**	23-Jun-2020	✓
Clear Plastic Bottle - Nitric Acid; Filtered (ED093F) P1, R12	**27-May-2020**	**----**	----	----	**10-Jun-2020**	24-Jun-2020	✓
Clear Plastic Bottle - Nitric Acid; Filtered (ED093F) L4	**28-May-2020**	**----**	----	----	**10-Jun-2020**	25-Jun-2020	✓
EK040P: Fluoride by PC Titrator							
Clear Plastic Bottle - Natural (EK040P) L1	**19-May-2020**	**----**	----	----	**05-Jun-2020**	16-Jun-2020	✓
Clear Plastic Bottle - Natural (EK040P) R4	**20-May-2020**	**----**	----	----	**05-Jun-2020**	17-Jun-2020	✓
Clear Plastic Bottle - Natural (EK040P) L2, RW1	**21-May-2020**	**----**	----	----	**05-Jun-2020**	18-Jun-2020	✓
Clear Plastic Bottle - Natural (EK040P) L3, R9	**25-May-2020**	**----**	----	----	**05-Jun-2020**	22-Jun-2020	✓
Clear Plastic Bottle - Natural (EK040P) R11	**26-May-2020**	**----**	----	----	**05-Jun-2020**	23-Jun-2020	✓
Clear Plastic Bottle - Natural (EK040P) P1, R12	**27-May-2020**	**----**	----	----	**05-Jun-2020**	24-Jun-2020	✓
Clear Plastic Bottle - Natural (EK040P) L4	**28-May-2020**	**----**	----	----	**05-Jun-2020**	25-Jun-2020	✓

Quality Control Parameter Frequency Compliance

The following report summarises the frequency of laboratory QC samples analysed within the analytical lot(s) in which the submitted sample(s) was(were) processed. Actual rate should be greater than or equal to the expected rate. A listing of breaches is provided in the Summary of Outliers.

Matrix: **WATER**

Evaluation: × = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Laboratory Duplicates (DUP)							
Alkalinity by PC Titrator	ED037-P	3	26	**11.54**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	2	17	**11.76**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Fluoride by PC Titrator	EK040P	1	10	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Major Cations - Dissolved	ED093F	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	2	19	**10.53**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Laboratory Control Samples (LCS)							
Alkalinity by PC Titrator	ED037-P	2	26	**7.69**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	2	17	**11.76**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Fluoride by PC Titrator	EK040P	1	10	**10.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Major Cations - Dissolved	ED093F	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	2	19	**10.53**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Method Blanks (MB)							
Chloride by Discrete Analyser	ED045G	1	17	**5.88**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Fluoride by PC Titrator	EK040P	1	10	**10.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Major Cations - Dissolved	ED093F	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Matrix Spikes (MS)							
Chloride by Discrete Analyser	ED045G	1	17	**5.88**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Fluoride by PC Titrator	EK040P	1	10	**10.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard

Brief Method Summaries

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the US EPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request. The following report provides brief descriptions of the analytical procedures employed for results reported in the Certificate of Analysis. Sources from which ALS methods have been developed are provided within the Method Descriptions.

Analytical Methods	Method	Matrix	Method Descriptions
Alkalinity by PC Titrator	ED037-P	WATER	In house: Referenced to APHA 2320 B This procedure determines alkalinity by automated measurement (e.g. PC Titrate) using pH 4.5 for indicating the total alkalinity end-point. This method is compliant with NEPM (2013) Schedule B(3)
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	WATER	In house: Referenced to APHA 4500-SO4. Dissolved sulfate is determined in a 0.45um filtered sample. Sulfate ions are converted to a barium sulfate suspension in an acetic acid medium with barium chloride. Light absorbance of the BaSO4 suspension is measured by a photometer and the SO4-2 concentration is determined by comparison of the reading with a standard curve. This method is compliant with NEPM (2013) Schedule B(3)
Chloride by Discrete Analyser	ED045G	WATER	In house: Referenced to APHA 4500 Cl - G.The thiocyanate ion is liberated from mercuric thiocyanate through sequestration of mercury by the chloride ion to form non-ionised mercuric chloride.in the presence of ferric ions the librated thiocynate forms highly-coloured ferric thiocynate which is measured at 480 nm APHA 21st edition seal method 2 017-1-L april 2003
Major Cations - Dissolved	ED093F	WATER	In house: Referenced to APHA 3120 and 3125; USEPA SW 846 - 6010 and 6020; Cations are determined by either ICP-AES or ICP-MS techniques. This method is compliant with NEPM (2013) Schedule B(3) Sodium Adsorption Ratio is calculated from Ca, Mg and Na which determined by ALS in house method QWI-EN/ED093F. This method is compliant with NEPM (2013) Schedule B(3) Hardness parameters are calculated based on APHA 2340 B. This method is compliant with NEPM (2013) Schedule B(3)
Fluoride by PC Titrator	EK040P	WATER	In house: Referenced to APHA 4500-F C: CDTA is added to the sample to provide a uniform ionic strength background, adjust pH, and break up complexes. Fluoride concentration is determined by either manual or automatic ISE measurement. This method is compliant with NEPM (2013) Schedule B(3)
Ionic Balance by PCT DA and Turbi SO4 DA	* EN055 - PG	WATER	In house: Referenced to APHA 1030F. This method is compliant with NEPM (2013) Schedule B(3)

CHAIN OF CUSTODY

ALS Laboratory: please tick →

ADELAIDE 3/1 Burma Road Pooraka SA 5095 Ph: 08 8162 5130 E: adelaide@alsglobal.com

BRISBANE 2 Byth Street Stafford QLD 4053 Ph: 07 3243 7222 E: samples.brisbane@alsglobal.com

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WOLLONGONG 1/19-21 Ralph Black Drive, Nth Wollongong NSW 2500 Ph: 02 4225 3125 E: wollongong@alsglobal.com

CLIENT: DPM Envirosciences Pty Ltd	**TURNAROUND REQUIREMENTS :** ☒ Standard TAT **(List due date):**	**FOR LABORATORY USE ONLY (Circle)**	
OFFICE: 12 Lauren Drive, BUDERIM QLD 4556	(Standard TAT may be longer for some tests e.g.. Ultra Trace Organics) ☐ Non Standard or urgent TAT **(List due date):**	Custody Seal Intact?	Yes No N/A
PROJECT: BMA Blackwater **PROJECT NO** DPM19014	**ALS QUOTE NO.:**	Free ice / frozen ice bricks present upon receipt?	Yes No N/A
ORDER NUMBER: **PURCHASE ORDER NO.:**	**COUNTRY OF ORIGIN:** Australia	Random Sample Temperature on Receipt:	°C
PROJECT MANAGER: David Moore **CONTACT PH:** 0427 694 433	COC SEQUENCE NUMBER (Circle) COC: 1 2 3 4 5 6 7 OF: 1 2 3 4 5 6 7	Other comment:	
SAMPLER: David Moore **SAMPLER MOBILE:** 0427 694 433	**RELINQUISHED BY:** DAVID MOORE	**RECEIVED BY:** Renata	**RELINQUISHED BY:**
COC Emailed to ALS? (YES / NO) **EDD FORMAT (or default):**	DATE/TIME: 5/6/2020 10:30	DATE/TIME: 5-6-2020 10-30	DATE/TIME:
Email Reports to (will default to PM if no other addresses are listed): dmoore@dpm-enviro.com.au			**RECEIVED BY:**
Email Invoice to (will default to PM if no other addresses are listed): dmoore@dpm-enviro.com.au			DATE/TIME:

COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:

ALS USE ONLY	SAMPLE DETAILS MATRIX: Solid(S) Water(W)			CONTAINER INFORMATION										Additional Information
LAB ID	SAMPLE ID	DATE / TIME	MATRIX	TYPE & PRESERVATIVE *(refer to codes below)*	TOTAL BOTTLES	NT-1D (Major cations [Ca, Mg, Na, K] + Hardness)	NT-2A (Major anions [Cl, SO4, F, Alkalinity)							Comments on likely contaminant levels, dilutions, or samples requiring specific QC analysis etc.
1	L1	19/05/2020	W	P, N	2	✓	✓							
2	R4	20/05/2020	W	P, N	2	✓	✓							
3	L2	21/05/2020	W	P, N	2	✓	✓							
4	RW1	21/05/2020	W	P, N	2	✓	✓							
5	L3	25/05/2020	W	P, N	2	✓	✓							
6	R9	25/05/2020	W	P, N	2	✓	✓							
7	R11	26/05/2020	W	P, N	2	✓	✓							
8	P1	27/05/2020	W	P, N	2	✓	✓							
9	R12	27/05/2020	W	P, N	2	✓	✓							
10	L4	28/05/2020	W	P, N	2	✓	✓							
				TOTAL	20									

Environmental Division
Brisbane
Work Order Reference
EB2014980

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Water Container Codes: P = Unpreserved Plastic; N = Nitric Preserved Plastic; ORC = Nitric Preserved ORC; SH = Sodium Hydroxide/Cd Preserved; S = Sodium Hydroxide Preserved Plastic; AG = Amber Glass Unpreserved; AP - Airfreight Unpreserved Plastic
V = VOA Vial HCl Preserved; VB = VOA Vial Sodium Bisulphate Preserved; VS = VOA Vial Sulfuric Preserved; AV = Airfreight Unpreserved Vial SG = Sulfuric Preserved Amber Glass; H = HCl preserved Plastic; HS = HCl preserved Speciation bottle; SP = Sulfuric Preserved Plastic; F = Formaldehyde Preserved Glass;
Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; ASS = Plastic Bag for Acic Sulphate Soils; B = Unpreserved Bag; LI = Lugols Iodine Preserved Bottles; STT = Sterile Sodium Thiosulfate Preserved Bottles.

Appendix C
Aquatic survey site profiles

EMM
creating opportunities

Table 1 **Sagittarius Creek – Dry**

Site: R1	Property: Mountain View	Stream order: 3	Latitude (GDA 94): -23.6017	Longitude (GDA 94): 148.8635	Date: 10/12/2019	Season: Dry

Upstream

Left bank

Downstream

Right bank

General site description

Site attributes

Ephemeral third order drainage line; dry at the time of assessment; well defined bed and banks; some local catchment erosion detected, including bank slumping; U shaped channel; concave banks; clay loam banks; banks moderately unstable (side slopes up to 60% on some banks), but with good bank vegetative stability; bankfull width approx. 7 m and bankfull height approx. 2 m; in-stream habitat features in times of flow would include some (10–50%) detritus, little (1-10%) sticks, branches and logs; bed substrates comprised approximately 5% bedrock, 1% boulder (>256 mm), 1% cobble (64–256 mm), 1% pebble (4–64 mm) and 92% silt/clay (<0.05 mm); upstream and adjacent land use includes moderate cattle grazing on land predominantly cleared of remnant vegetation.

Aquatic and riparian vegetation

Study reach positioned within riparian woodland State-mapped as non-remnant; field-verified as RE 11.3.1 – '*Acacia harpophylla* and/or *Casuarina cristata* open forest on alluvial plains'; riparian zone (of main channel) approximately 10 m on the left bank and 10 m on the right, comprising tall (11 m) open (25% crown cover) woodland dominated by brigalow (*Acacia harpophylla*), yellowwood (*Terminalia oblongata*) and coolabah (*Eucalyptus coolabah*), with frequent red bauhinia (*Lysiphyllum carronii*) and narrow-leaved bottletree (*Brachychiton rupestris*); shrub layer dominated by brigalow, with frequent currant bush (*Carissa ovata*) and native jasmine (*Jasminum didymum*), occasional soft turkey bush (*Acalypha eremorum*), false sandalwood (*Eremophila mitchellii*), boonaree (*Alectryon oleifolius*), limebush (*Citrus glauca*), sally wattle (*Acacia salicina*) and small-leaved ebony (*Diospyros humilis*); ground layer dominated by buffel grass (*Cenchrus ciliaris*)*, with frequent curly windmill grass (*Enteropogon acicularis*), occasional green panic (*Megathyrsus maximus*)*, mother-of-millions (*Bryophyllum delagoense*)* and Harrisia cactus (*Harrisia martinii*)*; semi-aquatic macrophytes in adjacent flood channel included little (1–10%) sedge (*Cyperus* sp.) and umbrella canegrass (*Leptochloa digitata*).

Erosion risk

Moderate – Banks appeared to be moderately unstable, but with 50–79% of the streambank surfaces covered by vegetation (including tree roots).

Aquatic fauna, including breeding habitat

No aquatic fauna detected. May provide breeding and foraging habitat for fish in times of flow. No turtle or platypus breeding habitat detected. Freshwater crab and mussel shells observed.

Critically Endangered, Endangered, Vulnerable, Near Threatened (CEEVNT), Special Least Concern (SLC), or Priority flora and fauna

No CEEVNT, SLC or Priority aquatic flora or fauna species detected. The Critically Endangered (EPBC Act; Endangered – NC Act) southern snapping turtle (*Elseya albagula*) and Vulnerable (EPBC Act and NC Act) Fitzroy River turtle (*Rheodytes leukops*) are recorded from the Mackenzie River Sub-basin (DES 2020). However, the study reach does not provide suitable habitat for these species.

Table 1 **Sagittarius Creek – Dry**

Site: R1	Property: Mountain View	Stream order: 3	Latitude (GDA 94): -23.6017	Longitude (GDA 94): 148.8635	Date: 10/12/2019	Season: Dry

Physico-chemical water quality

Dry at the time of assessment.

Bioassessment scores

Habitat assessment score for dry season: Fair (54).

Overall aquatic values

Dry season: **Low-Moderate**

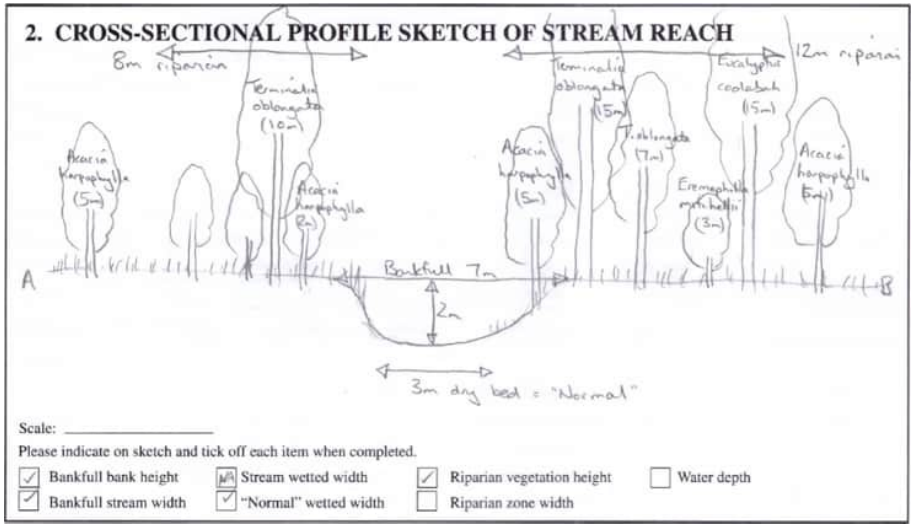


Table 2 **Sagittarius Creek – Late wet**

Site: R1	Property: Mountain View	Stream order: 3	Latitude (GDA 94): -23.6017	Longitude (GDA 94): 148.8635	Date: 19/05/2020	Season: Late wet

Upstream

Left bank

Downstream

Right bank

General Site Description

Site attributes

Ephemeral third order drainage line; debris indicates flood event since December 2019 survey, but dry at the time of assessment in May 2020; well defined bed and banks; some local catchment erosion detected, including bank slumping; U shaped channel; concave banks; clay loam banks; banks moderately unstable (side slopes up to 60% on some banks), but with good bank vegetative stability; bankfull width approx. 7 m and bankfull height approx. 2 m; in-stream habitat features in times of flow would include some (10–50%) detritus, little (1–10%) sticks, branches and logs; bed substrates comprised approximately 5% bedrock, 1% boulder (>256 mm), 1% cobble (64–256 mm), 1% pebble (4−64 mm) and 92% silt/clay (<0.05 mm); upstream and adjacent land use includes moderate cattle grazing on land predominantly cleared of remnant vegetation.

Aquatic and riparian vegetation

Study reach positioned within riparian woodland State-mapped as non-remnant; field-verified as RE 11.3.1 – '*Acacia harpophylla* and/or *Casuarina cristata* open forest on alluvial plains'; riparian zone (of main channel) approximately 10 m on the left bank and 10 m on the right, comprising tall (11 m) open (25% crown cover) woodland dominated by brigalow (*Acacia harpophylla*), yellowwood (*Terminalia oblongata*) and coolabah (*Eucalyptus coolabah*), with frequent red bauhinia (*Lysiphyllum carronii*) and narrow-leaved bottletree (*Brachychiton rupestris*); shrub layer dominated by brigalow, with frequent currant bush (*Carissa ovata*) and native jasmine (*Jasminum didymum*), occasional soft turkey bush (*Acalypha eremorum*), false sandalwood (*Eremophila mitchellii*), boonaree (*Alectryon oleifolius*), limebush (*Citrus glauca*), sally wattle (*Acacia salicina*) and small-leaved ebony (*Diospyros humilis*); ground layer dominated by buffel grass (*Cenchrus ciliaris*)*, with frequent curly windmill grass (*Enteropogon acicularis*), *Malvastrum* sp. and *Senna* sp., occasional parthenium (*Parthenium hysterophorus*)*, green panic (*Megathyrsus maximus*)*, mother-of-millions (*Bryophyllum delagoense*)* and Harrisia cactus (*Harrisia martinii*)*; semi-aquatic macrophytes included little (1–10%) *Cyperus betchei* and awnless barnyard grass (*Echinochloa colona*)*; semi-aquatic macrophytes in nearby flood channel included little (1–10%) pale knotweed (*Persicaria lapathifolia*), rice sedge (*Cyperus difformis*), dwarf sedge (*C. pygmaeus*), tall flatsedge (*C. exaltatus*), awnless barnyard grass*, umbrella canegrass (*Leptochloa digitata*) and white eclipta (*Eclipta prostrata*)*.

Erosion risk

Moderate – Banks appeared to be moderately unstable, but with 50–79% of the streambank surfaces covered by vegetation (including tree roots).

Table 2 **Sagittarius Creek – Late wet**

Site: R1	Property: Mountain View	Stream order: 3	Latitude (GDA 94): -23.6017	Longitude (GDA 94): 148.8635	Date: 19/05/2020	Season: Late wet

Aquatic fauna, including breeding habitat

No aquatic fauna detected. May provide foraging habitat and limited breeding habitat for fish in times of flow. No turtle or platypus breeding habitat detected. Freshwater crab and mussel shells observed.

Critically Endangered, Endangered, Vulnerable, Near Threatened (CEEVNT), Special Least Concern (SLC), or Priority flora and fauna

No EVNT, SLC or Priority aquatic flora or fauna species detected. The Critically Endangered (EPBC Act; Endangered – NC Act) southern snapping turtle (*Elseya albagula*) and Vulnerable (EPBC Act and NC Act) Fitzroy River turtle (*Rheodytes leukops*) are recorded from the Mackenzie River Sub-basin (DES 2020). However, the study reach does not provide suitable habitat for these species.

Physico-chemical water quality

Dry at the time of assessment.

Bioassessment scores

Habitat assessment score for dry season: Fair (54).

Overall aquatic values

Dry season: **Low-moderate**

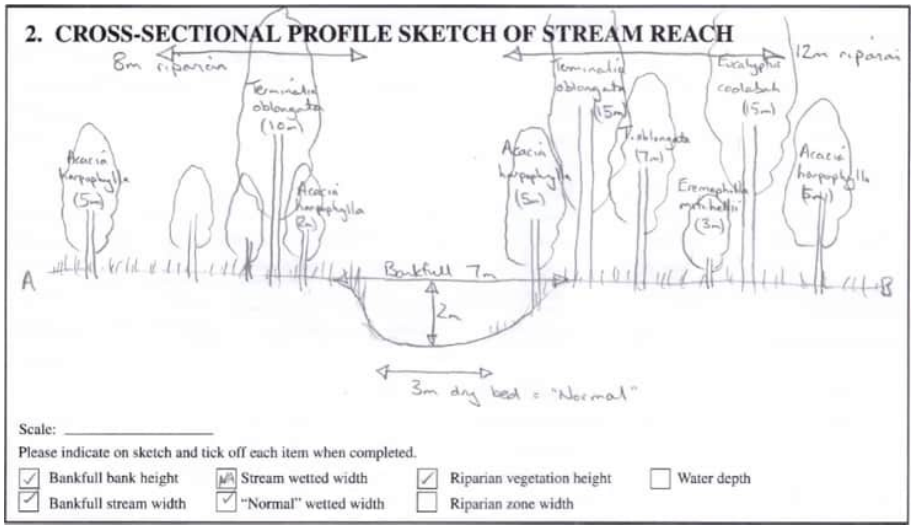


Table 3 **Sagittarius Creek – Dry**

Site: R2	Property: Mountain View	Stream order: 2	Latitude (GDA 94): -23.6527	Longitude (GDA 94): 148.8377	Date: 10/12/2019	Season: Dry

Upstream

Left bank

Downstream

Right bank

General Site Description

Site attributes

Ephemeral second order drainage line; dry at the time of assessment; moderately defined bed and banks; some local catchment erosion, including rill erosion; extensive gully erosion 100 m upstream; flat U shaped channel; convex banks; clay banks; banks moderately unstable (moderate frequency and size of erosional areas), fair bank vegetative stability; bankfull width approx. 8 m and bankfull height approx. 0.8 m; in-stream habitat features in times of flow would include little (1–10%) detritus, sticks and branches; bed substrates comprised 4% pebble (4–64 mm), 25% gravel (2–4 mm), 40% sand (0.05–2 mm) and 31% silt/clay (<0.05 mm); upstream land use includes coal mining and moderate cattle grazing on land cleared of native vegetation; adjacent land use includes moderate cattle grazing on land cleared of remnant vegetation.

Aquatic and riparian vegetation

Study reach positioned within regrowth woodland State-mapped as non-remnant; field-verified as non-remnant regrowth RE 11.4.9 or 11.9.5 – '*Acacia harpophylla* shrubby woodland with *Terminalia oblongata* on Cainozoic clay plains' / '*Acacia harpophylla* and/or *Casuarina cristata* open forest on fine-grained sedimentary rocks'; riparian zone approximately 5 m on the left bank and 5 m on the right, comprising low (4–5 m) very sparse (10–15% crown cover) woodland; canopy dominated by brigalow (*Acacia harpophylla*), with occasional whitewood (*Atalaya hemiglauca*) and yellowwood (*Terminalia oblongata*); very sparse shrub layer, dominated by brigalow suckers, with frequent currant bush (*Carissa ovata*) and harrisia cactus (*Harrisia martinii*)*, and occasional nipan (*Capparis lasiantha*); ground layer dominated by buffel grass (*Cenchrus ciliaris*)*, with frequent curly windmill grass (*Enteropogon acicularis*), soft roly-poly (*Salsola australis*), bluegrass (*Bothriochloa* sp.), and occasional common couch (*Cynodon dactylon*)*; no macrophytes detected.

Erosion risk

Moderate – Banks appeared to be moderately unstable, but with fair bank vegetative stability (24–49% of stream bank covered by vegetation, gravel or larger material). Further loss of riparian vegetation would result in high erosion risk.

Aquatic fauna, including breeding habitat

No aquatic fauna detected. May provide foraging habitat for highly mobile fish in times of flow. No fish, turtle or platypus breeding habitat detected.

Table 3 **Sagittarius Creek – Dry**

Site: R2	Property: Mountain View	Stream order: 2	Latitude (GDA 94): -23.6527	Longitude (GDA 94): 148.8377	Date: 10/12/2019	Season: Dry

Critically Endangered, Endangered, Vulnerable, Near Threatened (CEEVNT), Special Least Concern (SLC), or Priority flora and fauna

No CEEVNT, SLC or Priority aquatic flora or fauna species detected. The Critically Endangered (EPBC Act; Endangered – NC Act) southern snapping turtle (*Elseya albagula*) and Vulnerable (EPBC Act and NC Act) Fitzroy River turtle (*Rheodytes leukops*) are recorded from the Mackenzie River Sub-basin (DES 2020). However, the study reach does not provide suitable habitat for these species.

Physico-chemical water quality

Dry at the time of assessment.

Bioassessment scores

Habitat assessment score for dry season: Fair (51).

Overall aquatic values

Dry season: **Low**

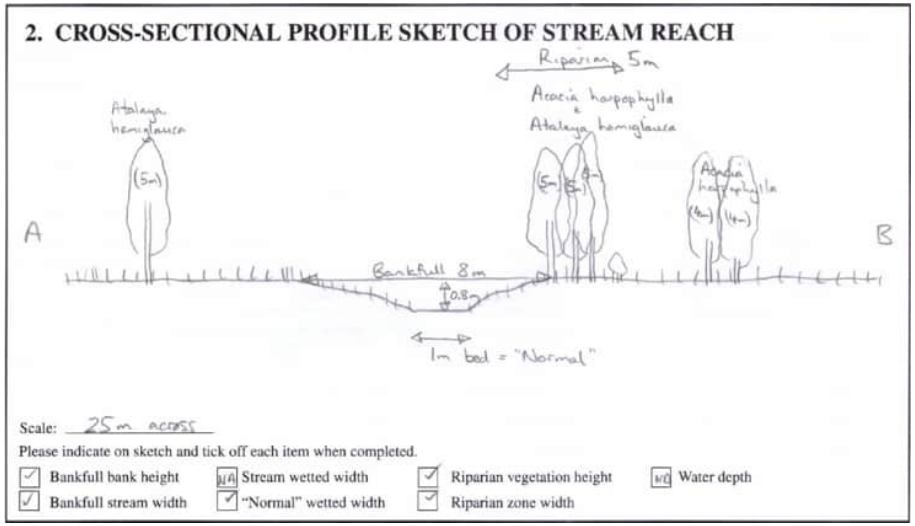


Table 4 **Sagittarius Creek – Late wet**

Site: R2	Property: Mountain View	Stream order: 2	Latitude (GDA 94): -23.6527	Longitude (GDA 94): 148.8377	Date: 19/05/2020	Season: Late wet

Upstream

Left bank

Downstream

Right bank

General Site Description

Site attributes

Ephemeral second order drainage line; debris indicates flood event since December 2019 survey, but dry at the time of assessment in May 2020; moderately defined bed and banks; some local catchment erosion, including rill erosion; extensive gully erosion 100 m upstream; flat U shaped channel; convex banks; clay banks; banks moderately unstable (moderate frequency and size of erosional areas), fair bank vegetative stability; bankfull width approx. 8 m and bankfull height approx. 0.8 m; in-stream habitat features in times of flow would include little (1–10%) detritus, sticks and branches; bed substrates comprised approx. 4% pebble (4–64 mm), 25% gravel (2–4 mm), 40% sand (0.05–2 mm) and 31% silt/clay (<0.05 mm); upstream land use includes coal mining and moderate cattle grazing on land cleared of native vegetation; adjacent land use includes moderate cattle grazing on land cleared of remnant vegetation.

Aquatic and riparian vegetation

Study reach positioned within regrowth woodland State-mapped as non-remnant; field-verified as non-remnant regrowth RE 11.4.9 or 11.9.5 – '*Acacia harpophylla* shrubby woodland with *Terminalia oblongata* on Cainozoic clay plains' / '*Acacia harpophylla* and/or *Casuarina cristata* open forest on fine-grained sedimentary rocks'; riparian zone approximately 5 m on the left bank and 5 m on the right, comprising low (4–5 m) very sparse (10–15% crown cover) woodland; canopy dominated by brigalow (*Acacia harpophylla*), with occasional whitewood (*Atalaya hemiglauca*) and yellowwood (*Terminalia oblongata*); very sparse shrub layer, dominated by brigalow suckers, with frequent currant bush (*Carissa ovata*) and harrisia cactus (*Harrisia martinii*)*, and occasional nipan (*Capparis lasiantha*); ground layer dominated by buffel grass (*Cenchrus ciliaris*)*, with frequent curly windmill grass (*Enteropogon acicularis*), red spinach (*Trianthema triquetra*), soft roly-poly (*Salsola australis*) and forest bluegrass (*Bothriochloa bladhii*), and occasional common couch (*Cynodon dactylon*)*, button grass (*Dactyloctenium radulans*), nodding saltbush (*Einadia nutans*) and black roly-poly (*Sclerolaena muricata*); no macrophytes detected.

Erosion risk

Moderate – Banks appeared to be moderately unstable, but with fair bank vegetative stability (24–49% of stream bank covered by vegetation, gravel or larger material). Further loss of riparian vegetation would result in high erosion risk.

Aquatic fauna, including breeding habitat

No aquatic fauna detected. May provide foraging habitat for highly mobile fish in times of flow. No fish, turtle or platypus breeding habitat detected.

Critically Endangered, Endangered, Vulnerable, Near Threatened (CEEVNT), Special Least Concern (SLC), or Priority flora and fauna

No EVNT, SLC or Priority aquatic flora or fauna species detected. The Critically Endangered (EPBC Act; Endangered – NC Act) southern snapping turtle (*Elseya albagula*) and Vulnerable (EPBC Act and NC Act) Fitzroy River turtle (*Rheodytes leukops*) are recorded from the Mackenzie River Sub-basin (DES 2020). However, the study reach does not provide suitable habitat for these species.

Table 4 **Sagittarius Creek – Late wet**

Site: R2	Property: Mountain View	Stream order: 2	Latitude (GDA 94): -23.6527	Longitude (GDA 94): 148.8377	Date: 19/05/2020	Season: Late wet
Physico-chemical water quality						
Dry at the time of assessment.						
Bioassessment scores						
Habitat assessment score for dry season: Fair (51).						
Overall aquatic values						
Dry season: **Low**						

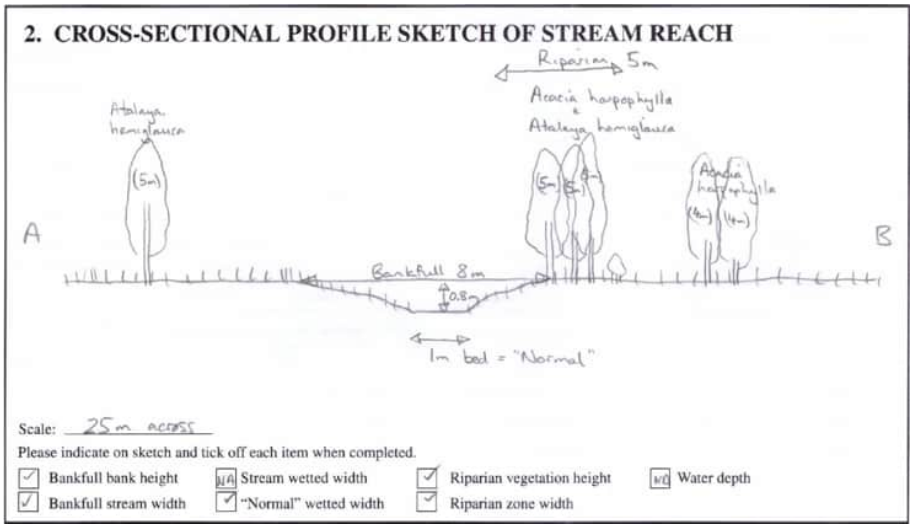


Table 5 **Unnamed tributary – Dry**

Site: R3	Property: Taurus	Stream order: 1	Latitude (GDA 94): -23.6933	Longitude (GDA 94): 148.8567	Date: 11/12/2019	Season: Dry

Upstream

Left bank

Downstream

Right bank

General Site Description

Site attributes

Ephemeral first order drainage line; dry at the time of assessment; well defined bed and banks; moderate local catchment erosion, including bank slumping; U shaped channel; clay banks; banks unstable (many eroded areas with side slopes >60% common), but with fair bank vegetative stability; bankfull width approx. 5 m and bankfull height approx. 1.5 m; in-stream habitat features in times of flow would include little (1–10%) detritus, sticks, branches and logs; bed substrates comprised approx. 10% gravel (2–4 mm), 70% sand (0.05–2 mm) and 20% silt/clay (<0.05 mm); upstream and adjacent land use includes moderate cattle grazing on land predominantly cleared of remnant vegetation.

Aquatic and riparian vegetation

Study reach positioned within riparian woodland State-mapped as non-remnant; field-verified small patch of RE 11.4.9, surrounded by regrowth; riparian zone (of main channel) approximately 10 m on the left bank and 10 m on the right, comprising medium-tall (10 m) open (30% crown cover) woodland dominated by brigalow (*Acacia harpophylla*), with frequent yellowwood (*Terminalia oblongata*) and red bauhinia (*Lysiphyllum carronii*); sparse sub-canopy, with frequent brigalow, false sandalwood (*Eremophila mitchellii*), occasional red bauhinia and rare emu apple (*Owenia acidula*); very sparse shrub layer dominated by brigalow, with frequent Harrisia cactus (*Harrisia martinii*)*, occasional red bauhinia, scrub boonaree (*Alectryon diversifolius*), currant bush (*Carissa ovata*) and whitewood (*Atalaya hemiglauca*); ground layer dominated by buffel grass (*Cenchrus ciliaris*)*, with frequent curly windmill grass (*Enteropogon acicularis*), occasional mother-of-millions (*Bryophyllum delagoense*)* and rare occurrence of the Endangered (NC Act) *Solanum elachophyllum*. No aquatic macrophytes detected.

Erosion risk

Moderate-high – Banks unstable, but with fair bank vegetative stability (24–49% of stream bank covered by vegetation [including roots], gravel or larger material). Further loss of riparian vegetation would result in high erosion risk.

Aquatic fauna, including breeding habitat

No aquatic fauna detected. May provide foraging habitat for highly mobile fish in times of flow. No fish, turtle or platypus breeding habitat detected.

Critically Endangered, Endangered, Vulnerable, Near Threatened (CEEVNT), Special Least Concern (SLC), or Priority flora and fauna

No CEEVNT, SLC or Priority aquatic flora or fauna species detected. The Critically Endangered (EPBC Act; Endangered – NC Act) southern snapping turtle (*Elseya albagula*) and Vulnerable (EPBC Act and NC Act) Fitzroy River turtle (*Rheodytes leukops*) are recorded from the Mackenzie River Sub-basin (DES 2020). However, the study reach does not provide suitable habitat for these species.

Table 5 **Unnamed tributary – Dry**

Site: R3	Property: Taurus	Stream order: 1	Latitude (GDA 94): -23.6933	Longitude (GDA 94): 148.8567	Date: 11/12/2019	Season: Dry

Physico-chemical water quality

Dry at the time of assessment.

Bioassessment scores

Habitat assessment score for dry season: Poor (29).

Overall aquatic values

Dry season: **Low**

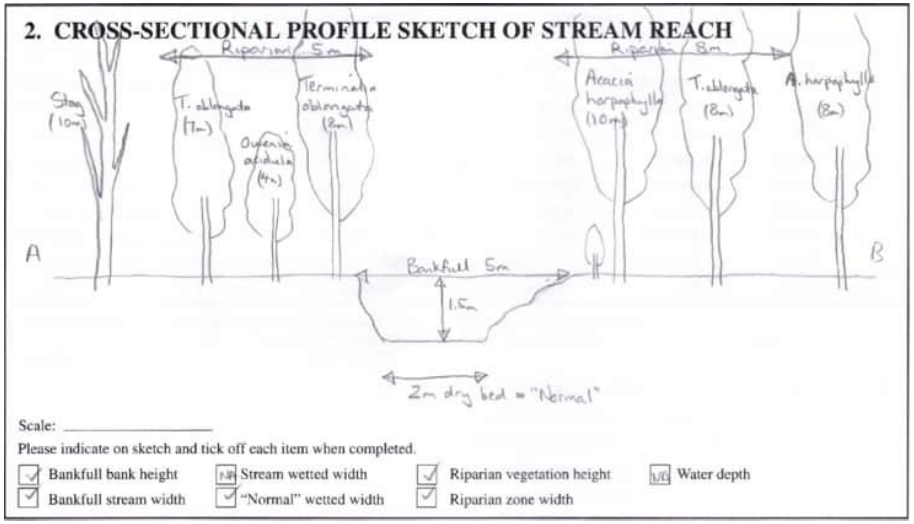


Table 6 **Unnamed tributary – Late wet**

Site: R3	Property: Taurus	Stream order: 1	Latitude (GDA 94): -23.6933	Longitude (GDA 94): 148.8567	Date: 21/05/2020	Season: Late wet

Upstream

Left bank

Downstream

Right bank

General Site Description

Site attributes

Ephemeral first order drainage line; debris indicates flood event since December 2019 survey, but dry at the time of assessment in May 2020; well defined bed and banks; moderate local catchment erosion, including bank slumping; U shaped channel; clay banks; banks unstable (many eroded areas with side slopes >60% common), but with fair bank vegetative stability; bankfull width approx. 5 m and bankfull height approx. 1.5 m; in-stream habitat features in times of flow would include little (1–10%) detritus, sticks, branches and logs; bed substrates comprised approx. 10% gravel (2–4 mm), 70% sand (0.05–2 mm) and 20% silt/clay (<0.05 mm); upstream and adjacent land use includes moderate cattle grazing on land predominantly cleared of remnant vegetation.

Aquatic and riparian vegetation

Study reach positioned within riparian woodland State-mapped as non-remnant; field-verified small patch of RE 11.4.9, surrounded by regrowth; riparian zone (of main channel) approximately 10 m on the left bank and 10 m on the right, comprising medium-tall (10 m) open (30% crown cover) woodland dominated by brigalow (*Acacia harpophylla*), with frequent yellowwood (*Terminalia oblongata*) and red bauhinia (*Lysiphyllum carronii*); sparse sub-canopy with frequent brigalow, false sandalwood (*Eremophila mitchellii*), occasional red bauhinia and rare emu apple (*Owenia acidula*); very sparse shrub layer dominated by brigalow, with frequent Harrisia cactus (*Harrisia martinii*)*, occasional red bauhinia, scrub boonaree (*Alectryon diversifolius*), currant bush (*Carissa ovata*) and whitewood (*Atalaya hemiglauca*); ground layer dominated by buffel grass (*Cenchrus ciliaris*)*, with abundant parthenium (*Parthenium hysterophorus*)*, frequent curly windmill grass (*Enteropogon acicularis*), desert petunia (*Dipteracanthus australasicus*), ruby saltbush (*Enchylaena tomentosa*), spiked malvastrum (*Malvastrum americanum*), flannel weed (*Abutilon oxycarpum*), occasional mother-of-millions (*Bryophyllum delagoense*)* and rare occurrence of the Endangered (NC Act) *Solanum elachophyllum*. No aquatic macrophytes detected.

Erosion risk

Moderate-high – Banks unstable, but with fair bank vegetative stability (24–49% of stream bank covered by vegetation [including roots], gravel or larger material). Further loss of riparian vegetation would result in high erosion risk.

Aquatic fauna, including breeding habitat

No aquatic fauna detected. May provide foraging habitat for highly mobile fish in times of flow. No fish, turtle or platypus breeding habitat detected.

Critically Endangered, Endangered, Vulnerable, Near Threatened (CEEVNT), Special Least Concern (SLC), or Priority flora and fauna

No CEEVNT, SLC or Priority aquatic flora or fauna species detected. The Critically Endangered (EPBC Act; Endangered – NC Act) southern snapping turtle (*Elseya albagula*) and Vulnerable (EPBC Act and NC Act) Fitzroy River turtle (*Rheodytes leukops*) are recorded from the Mackenzie River Sub-basin (DES 2020). However, the study reach does not provide suitable habitat for these species.

Table 6 **Unnamed tributary – Late wet**

Site: R3	Property: Taurus	Stream order: 1	Latitude (GDA 94): -23.6933	Longitude (GDA 94): 148.8567	Date: 21/05/2020	Season: Late wet

Physico-chemical water quality

Dry at the time of assessment.

Bioassessment scores

Habitat assessment score for dry season: Poor (29).

Overall aquatic values

Dry season: **Low**

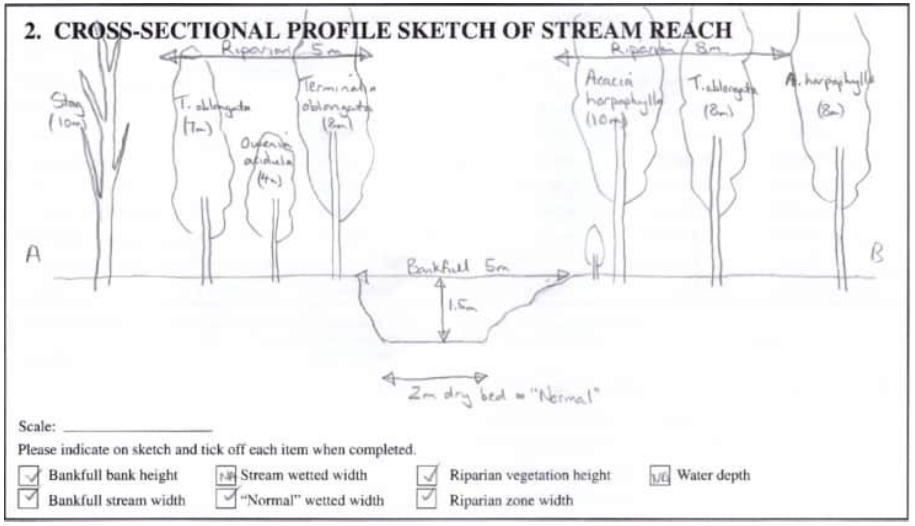


Table 7 **Taurus Creek – Dry**

Site: R4	Property: Mountain View	Stream order: 4	Latitude (GDA 94): -23.6743	Longitude (GDA 94): 148.8671	Date: 11/12/2019	Season: Dry

Upstream

Left bank

Downstream

Right bank

General Site Description

Site attributes

Ephemeral fourth order drainage line; pooled water at the time of assessment due to burst stock watering pipe nearby, that had since been repaired; well defined bed and banks; little local catchment erosion, including rill, gully and bank slumping; U shaped channel; concave banks; clay banks; banks moderately unstable (side slopes up to 60% on some banks), but with good bank vegetative stability; bankfull width approx. 20 m and bankfull height approx. 4.5 m; in-stream habitat features included shallow and deep (>0.5 m) pool, macrophytes, detritus, sticks, branches and logs; bed substrates comprised approx. 30% sand (0.05–2 mm) and 70% silt/clay (<0.05 mm); edge habitat substrates comprised approx. 20% sand and 80% silt/clay; upstream and adjacent land use includes moderate cattle grazing on land predominantly cleared of remnant vegetation; feral pig (*Sus scrofa*) resting in waterbody on arrival.

Aquatic and riparian vegetation

Study reach positioned within riparian woodland State-mapped as mixed RE 11.3.2 / 11.3.25 / 11.3.1; field-verified as RE 11.3.1 – '*Acacia harpophylla* and/or *Casuarina cristata* open forest on alluvial plains'; riparian zone approximately 10 m on the left bank and 10 m on the right, comprising tall (20 m) open (30% crown cover) woodland dominated by (infested with) rubber vine (*Cryptostegia grandiflora*)*, with abundant brigalow (*Acacia harpophylla*), frequent yellowwood (*Terminalia oblongata*), coolabah (*Eucalyptus coolabah*) and narrow-leaved bottletree (*Brachychiton rupestris*); sparse sub-canopy dominated by rubber vine*, with frequent yellowwood, occasional white bauhinia (*Lysiphyllum hookeri*) and bean tree (*Cassia brewsteri*), very sparse shrub layer, including yellowwood; ground layer of the upper bank dominated by buffel grass (*Cenchrus ciliaris*)*, with abundant mother-of-millions (*Bryophyllum delagoense*)*; ground layer of the lower bank dominated by water primrose (*Ludwigia peploides*), with occasional umbrella canegrass (*Leptochloa digitata*) and tall flatsedge (*Cyperus exaltatus*); semi-aquatic macrophytes included some (10–50%) water primrose, little (1–10%) umbrella canegrass and *C. exaltatus*.

Erosion risk

Moderate – Banks appeared to be moderately unstable, but with 50–79% of the streambank surfaces covered by vegetation (including tree roots).

Aquatic fauna, including breeding habitat

The reach provides potential foraging and breeding habitat for fish and common turtle species. No suitable platypus breeding habitat detected. Aquatic fauna detected by backpack electrofishing and overnight deployment of two baited fyke nets and five baited box traps included gudgeon (*Hypseleotris galii* / sp. 1), western carp gudgeon (*H. klunzingeri*), eastern rainbowfish (*Melanotaenia splendida*), fly-specked hardyhead (*Craterocephalus stercusmuscarum*), Agassiz's glassfish (*Ambassis agassizii*), spangled perch (*Leiopotherapon unicolor*) and purple-spotted gudgeon (*Mogurnda adspersa*).

Table 7 **Taurus Creek – Dry**

Site: R4	Property: Mountain View	Stream order: 4	Latitude (GDA 94): -23.6743	Longitude (GDA 94): 148.8671	Date: 11/12/2019	Season: Dry

Critically Endangered, Endangered, Vulnerable, Near Threatened (CEEVNT), Special Least Concern (SLC), or Priority flora and fauna

No CEEVNT, SLC or Priority aquatic flora or fauna species detected. The Critically Endangered (EPBC Act; Endangered – NC Act) southern snapping turtle (*Elseya albagula*) and Vulnerable (EPBC Act and NC Act) Fitzroy River turtle (*Rheodytes leukops*) are recorded from the Mackenzie River Sub-basin (DES 2020). However, the study reach does not provide suitable habitat for these species.

Physico-chemical water quality

Collection time: 12:00; water temp: 26.7˚C; specific conductivity: 387 µS/cm (fresh); turbidity: 24 NTU (good clarity); dissolved oxygen: 36.0%, 2.9 mg/L (low for time of day when DO levels should be nearing their diurnal peak); pH: 7.9 (moderately alkaline, likely reflecting the clay catchment). Comments: Most parameters normal; low DO likely due to a combination of factors, including oxygen consumption by bacteria during the breakdown of organic matter, and shading by rubber vine* leading to reduced photosynthetic respiration of oxygen by algae and macrophytes.

Bioassessment scores

Habitat assessment score for dry season: Fair (59).

Overall aquatic values

Dry season: **Moderate**

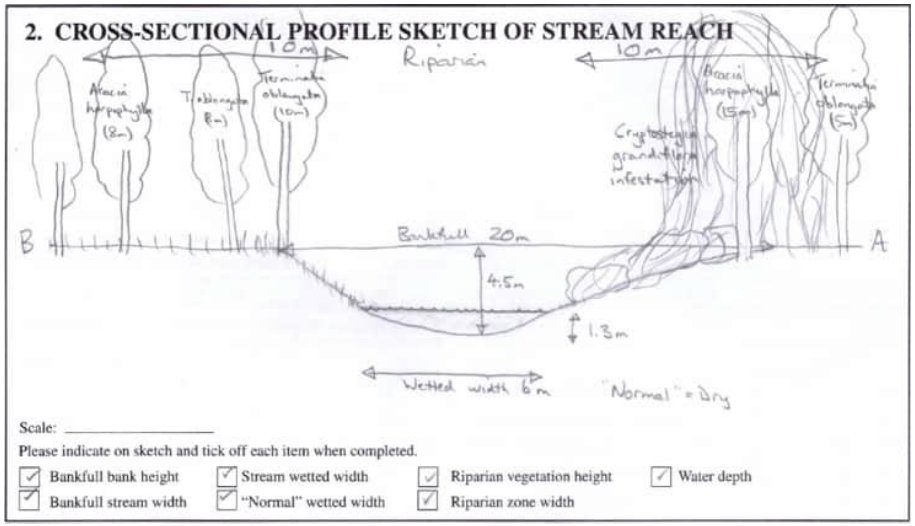


Table 8 **Taurus Creek – Late wet**

Site: R4	Property: Mountain View	Stream order: 4	Latitude (GDA 94): -23.6743	Longitude (GDA 94): 148.8671	Date: 20/05/2020	Season: Late wet

Upstream

Left bank

Downstream

Right bank

General Site Description

Site attributes

Ephemeral fourth order drainage line; isolated pools at the time of assessment; debris indicates flood event since December 2019 survey; well defined bed and banks; little local catchment erosion, including rill, gully and bank slumping; U shaped channel; concave banks; clay banks; banks moderately unstable (side slopes up to 60% on some banks), but with good bank vegetative stability; bankfull width approx. 20 m and bankfull height approx. 4.5 m; in-stream habitat features included shallow and deep (>0.5 m) pool, macrophytes, detritus, sticks, branches and logs; bed substrates comprised approx. 30% sand (0.05–2 mm) and 70% silt/clay (<0.05 mm); edge habitat substrates comprised approx. 20% sand and 80% silt/clay; upstream and adjacent land use includes moderate cattle grazing on land predominantly cleared of remnant vegetation.

Aquatic and riparian vegetation

Study reach positioned within riparian woodland State-mapped as mixed RE 11.3.2 / 11.3.25 / 11.3.1; field-verified as RE 11.3.1 – '*Acacia harpophylla* and/or *Casuarina cristata* open forest on alluvial plains'; riparian zone approximately 10 m on the left bank and 10 m on the right, comprising tall (20 m) open (30% crown cover) woodland dominated by (infested with) rubber vine (*Cryptostegia grandiflora*)*, with abundant brigalow (*Acacia harpophylla*), frequent yellowwood (*Terminalia oblongata*), coolabah (*Eucalyptus coolabah*) and narrow-leaved bottletree (*Brachychiton rupestris*); sparse sub-canopy dominated by rubber vine*, with frequent yellowwood, occasional white bauhinia (*Lysiphyllum hookeri*) and bean tree (*Cassia brewsteri*), very sparse shrub layer, including yellowwood; ground layer of the upper bank dominated by buffel grass (*Cenchrus ciliaris*)*, with abundant parthenium (*Parthenium hysterophorus*)* and frequent mother-of-millions (*Bryophyllum delagoense*)*; semi-aquatic macrophytes included little (1–10%) water primrose (*Ludwigia peploides*), *Cyperus betchei* and rice flatsedge (*C. iria*).

Erosion risk

Moderate – Banks appeared to be moderately unstable, but with 50–79% of the streambank surfaces covered by vegetation (including tree roots).

Aquatic fauna, including breeding habitat

The reach provides potential foraging and breeding habitat for fish and common turtle species. No suitable platypus breeding habitat detected. Aquatic fauna detected by backpack electrofishing and overnight deployment of two baited fyke nets and five baited box traps included gudgeon (*Hypseleotris galii* / sp. 1), eastern rainbowfish (*Melanotaenia splendida*), Agassiz's glassfish (*Ambassis agassizii*), spangled perch (*Leiopotherapon unicolor*), bony bream (*Nematalosa erebi*), purple-spotted gudgeon (*Mogurnda adspersa*), Rendahl's catfish (*Porochilus rendahli*) and Hyrtyl's tandan (*Neosilurus hyrtlii*).

Table 8 **Taurus Creek – Late wet**

Site: R4	Property: Mountain View	Stream order: 4	Latitude (GDA 94): -23.6743	Longitude (GDA 94): 148.8671	Date: 20/05/2020	Season: Late wet

Critically Endangered, Endangered, Vulnerable, Near Threatened (CEEVNT), Special Least Concern (SLC), or Priority flora and fauna

No CEEVNT, SLC or Priority aquatic flora or fauna species detected. The Critically Endangered (EPBC Act; Endangered – NC Act) southern snapping turtle (*Elseya albagula*) and Vulnerable (EPBC Act and NC Act) Fitzroy River turtle (*Rheodytes leukops*) are recorded from the Mackenzie River Sub-basin (DES 2020). However, the study reach does not provide suitable habitat for these species.

Physico-chemical water quality

Collection time: 10:30; water temp.: 19.0˚C; specific conductivity: 676 µS/cm (fresh); turbidity: 40 NTU (good clarity); dissolved oxygen: 20.3%, 1.9 mg/L (low); pH: 7.6 (mildly alkaline, likely reflecting the clay catchment). Comments: Most parameters normal; low DO likely due to a combination of factors, including oxygen consumption by bacteria during the breakdown of organic matter, and shading by rubber vine* leading to reduced photosynthetic respiration of oxygen by algae and macrophytes.

Bioassessment scores

Habitat assessment score for dry season: Fair (59).

Overall aquatic values

Dry season: **Moderate**

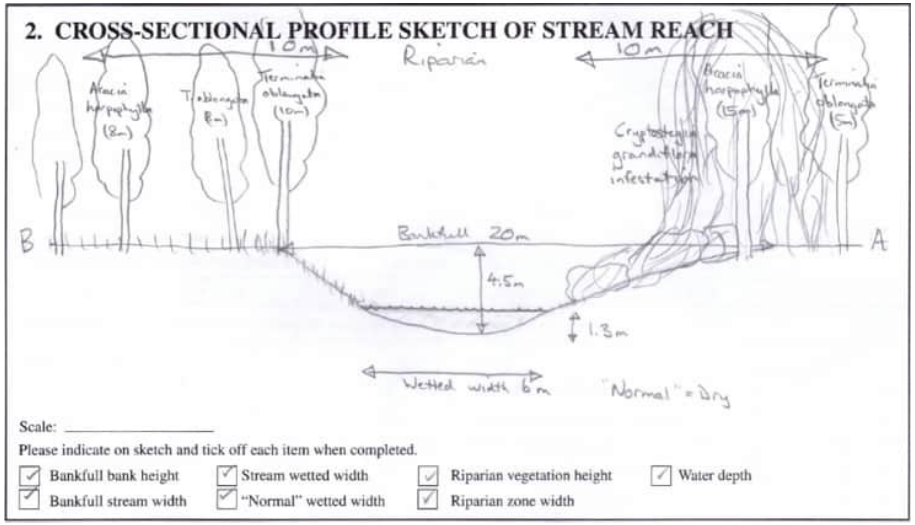


Table 9 **Taurus Creek – Dry**

Site: R5	Property: Taurus	Stream order: 3	Latitude (GDA 94): -23.7165	Longitude (GDA 94): 148.8544	Date: 12/12/2019	Season: Dry

Upstream

Left bank

Downstream

Right bank

General Site Description

Site attributes

Ephemeral third order drainage line; dry at the time of assessment; well defined bed and banks; some local catchment erosion detected, including bank slumping; convex banks, flat U shaped channel, as a result of sand deposition; both clay and sandy loam banks; banks moderately unstable (side slopes up to 60% on some banks); fair bank vegetative stability; bankfull width approx. 22 m and bankfull height approx. 3 m; in-stream habitat features in times of flow would include little (1–10%) detritus, sticks and branches; bed substrates comprised approximately 10% gravel (2–4 mm) and 90% sand (0.05–2 mm); upstream land use includes mining and moderate cattle grazing on land predominantly cleared of remnant vegetation; adjacent land use includes light cattle grazing.

Aquatic and riparian vegetation

Study reach positioned within riparian woodland State-mapped as non-remnant; field-verified as mixed RE 11.3.1 / 11.3.25 – '*Acacia harpophylla* and/or *Casuarina cristata* open forest on alluvial plains' / '*Eucalyptus tereticornis* or *E. camaldulensis* woodland fringing drainage lines'; riparian zone approximately 20 m on the left bank and 20 m on the right, comprising tall (17 m) open (20% crown cover) woodland dominated by yellowwood (*Terminalia oblongata*), with frequent brigalow (*Acacia harpophylla*), narrow-leaved bottletree (*Brachychiton rupestris*), occasional Queensland blue gum (*Eucalyptus tereticornis*), silver-leaved ironbark (*E. melanophloia*), poplar box (*E. populnea*) and boonaree (*Alectryon oleifolius*); sparse sub-canopy dominated by white bauhinia (*Lysiphyllum hookeri*), yellowwood and brigalow, with occasional false sandalwood (*Eremophila mitchellii*), emu apple (*Owenia acidula*), sally wattle (*Acacia salicina*), carbeen (*Corymbia tessellaris*) and sandalwood (*Santalum lanceolatum*); very sparse shrub layer, including currant bush (*Carissa ovata*), nipan (*Capparis lasiantha*), soft turkey bush (*Acalypha eremorum*) and whitewood (*Atalaya hemiglauca*); ground layer dominated by buffel grass (*Cenchrus ciliaris*)*, with occasional wiregrass (*Aristida* sp.), green panic (*Megathyrsus maximus*)*, Harrisia cactus (*Harrisia martinii*)* and velvet tree pear (Opuntia tomentosa)*; no macrophytes detected.

Erosion risk

Moderate-high – Banks appeared to be moderately unstable, with 25–49% of the streambank surfaces covered by vegetation (including tree roots).

Aquatic fauna, including breeding habitat

No aquatic fauna detected. May provide breeding and foraging habitat for fish in times of flow. No turtle or platypus breeding habitat detected.

Critically Endangered, Endangered, Vulnerable, Near Threatened (CEEVNT), Special Least Concern (SLC), or Priority flora and fauna

No CEEVNT, SLC or Priority aquatic flora or fauna species detected. The Critically Endangered (EPBC Act; Endangered – NC Act) southern snapping turtle (*Elseya albagula*) and Vulnerable (EPBC Act and NC Act) Fitzroy River turtle (*Rheodytes leukops*) are recorded from the Mackenzie River Sub-basin (DES 2020). However, the study reach does not provide suitable habitat for these species.

Table 9 **Taurus Creek – Dry**

Site: R5	Property: Taurus	Stream order: 3	Latitude (GDA 94): -23.7165	Longitude (GDA 94): 148.8544	Date: 12/12/2019	Season: Dry
Physico-chemical water quality						
Dry at the time of assessment.						
Bioassessment scores						
Habitat assessment score for dry season: Poor (37).						
Overall aquatic values						
Dry season: **Moderate**						

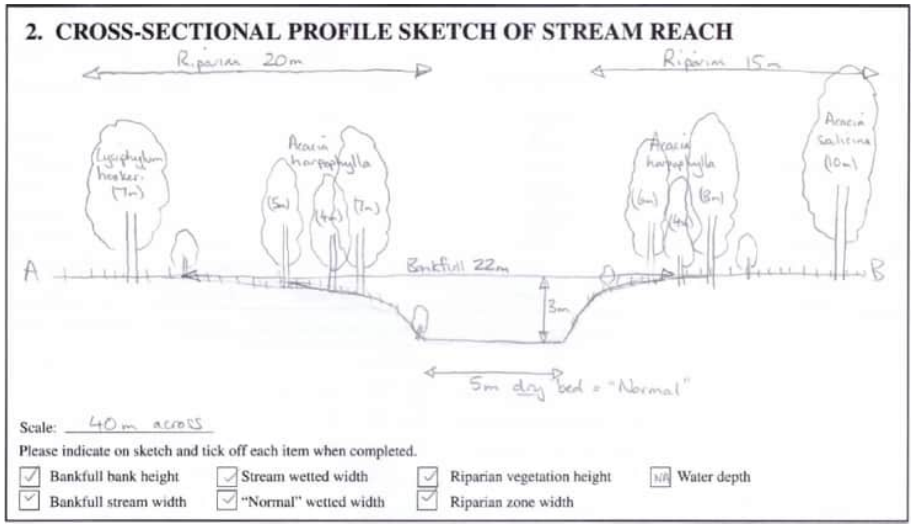


Table10 **Taurus Creek – Late wet**

Site: R5	Property: Taurus	Stream order: 3	Latitude (GDA 94): -23.7165	Longitude (GDA 94): 148.8544	Date: 21/05/2020	Season: Late wet

Upstream

Left bank

Downstream

Right bank

General Site Description

Site attributes

Ephemeral third order drainage line; debris indicates flood event since December 2019 survey, but dry at the time of assessment in May 2020; well defined bed and banks; some local catchment erosion detected, including bank slumping; convex banks, flat U shaped channel, as a result of sand deposition; both clay and sandy loam banks; banks moderately unstable (side slopes up to 60% on some banks); fair bank vegetative stability; bankfull width approx. 22 m and bankfull height approx. 3 m; in-stream habitat features in times of flow would include little (1–10%) detritus, sticks and branches; bed substrates comprised approximately 10% gravel (2–4 mm), 75% sand (0.05–2 mm) and a thin veneer of approximately 15% silt (<0.05 mm); upstream land use includes mining and moderate cattle grazing on land predominantly cleared of remnant vegetation; adjacent land use includes light cattle grazing.

Aquatic and riparian vegetation

Study reach positioned within riparian woodland State-mapped as non-remnant; field-verified as mixed RE 11.3.1 / 11.3.25 – '*Acacia harpophylla* and/or *Casuarina cristata* open forest on alluvial plains' / '*Eucalyptus tereticornis* or *E. camaldulensis* woodland fringing drainage lines'; riparian zone approximately 20 m on the left bank and 20 m on the right, comprising tall (17 m) open (20% crown cover) woodland dominated by yellowwood (*Terminalia oblongata*), with frequent brigalow (*Acacia harpophylla*), narrow-leaved bottletree (*Brachychiton rupestris*), occasional Queensland blue gum (*Eucalyptus tereticornis*), silver-leaved ironbark (*E. melanophloia*), poplar box (*E. populnea*) and boonaree (*Alectryon oleifolius*); sparse sub-canopy dominated by white bauhinia (*Lysiphyllum hookeri*), yellowwood and brigalow, with occasional false sandalwood (*Eremophila mitchellii*), emu apple (*Owenia acidula*), sally wattle (*Acacia salicina*), carbeen (*Corymbia tessellaris*) and sandalwood (*Santalum lanceolatum*); very sparse shrub layer, including currant bush (*Carissa ovata*), nipan (*Capparis lasiantha*), soft turkey bush (*Acalypha eremorum*) and whitewood (*Atalaya hemiglauca*); ground layer dominated by buffel grass (*Cenchrus ciliaris*)*, with occasional wiregrass (*Aristida* sp.), green panic (*Megathyrsus maximus*)*, Harrisia cactus (*Harrisia martinii*)* and velvet tree pear (Opuntia tomentosa)*; no macrophytes detected.

Erosion risk

Moderate-high – Banks appeared to be moderately unstable, with 25–49% of the streambank surfaces covered by vegetation (including tree roots).

Aquatic fauna, including breeding habitat

No aquatic fauna detected. May provide breeding and foraging habitat for fish in times of flow. No turtle or platypus breeding habitat detected.

Critically Endangered, Endangered, Vulnerable, Near Threatened (CEEVNT), Special Least Concern (SLC), or Priority flora and fauna

No CEEVNT, SLC or Priority aquatic flora or fauna species detected. The Critically Endangered (EPBC Act; Endangered – NC Act) southern snapping turtle (*Elseya albagula*) and Vulnerable (EPBC Act and NC Act) Fitzroy River turtle (*Rheodytes leukops*) are recorded from the Mackenzie River Sub-basin (DES 2020). However, the study reach does not provide suitable habitat for these species.

Table10 **Taurus Creek – Late wet**

Site: R5	Property: Taurus	Stream order: 3	Latitude (GDA 94): -23.7165	Longitude (GDA 94): 148.8544	Date: 21/05/2020	Season: Late wet

Physico-chemical water quality

Dry at the time of assessment.

Bioassessment scores

Habitat assessment score for dry season: Poor (37).

Overall aquatic values

Dry season: **Moderate**

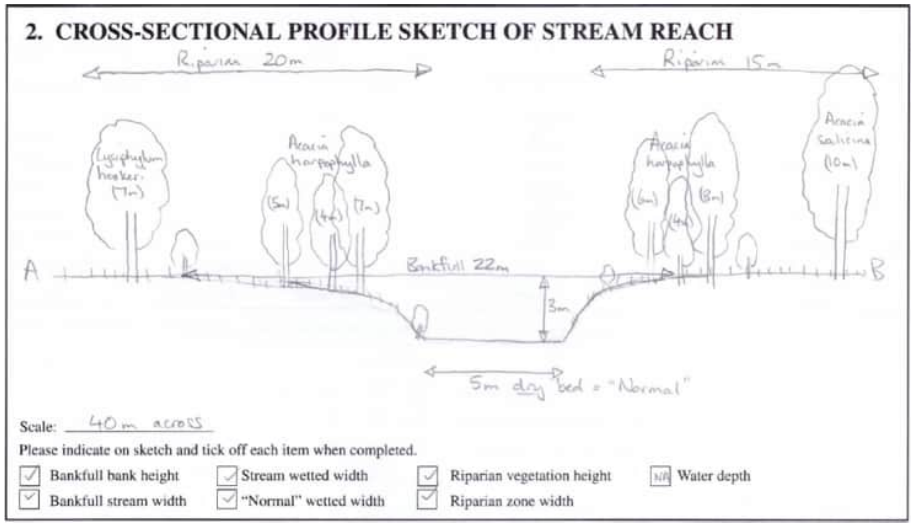


Table 11 **Two Mile Gully - Dry**

Site: R6	Property: Taurus	Stream order: 4	Latitude (GDA 94): -23.7309	Longitude (GDA 94): 148.8737	Date: 12/12/2019	Season: Dry

Upstream

Left bank

Downstream

Right bank

General Site Description

Site attributes

Ephemeral fourth order drainage line; dry at the time of assessment; well defined bed and banks; little local catchment erosion, including bank slumping; convex banks, flat U shaped channel, as a result of sand deposition; sandy clay banks; banks moderately unstable (side slopes up to 60% on some banks); fair bank vegetative stability; bankfull width approx. 15 m and bankfull height approx. 4 m; in-stream habitat features in times of flow would include little (1–10%) detritus, sticks, branches and logs; bed substrates comprised approximately 2% pebble (4–64 mm), 40% gravel (2–4 mm) and 58% sand (0.05–2 mm); upstream and adjacent land use includes cattle grazing on land predominantly cleared of remnant vegetation.

Aquatic and riparian vegetation

Study reach positioned within riparian woodland State-mapped as non-remnant; field-verified as RE 11.3.2 – '*Eucalyptus populnea* woodland on alluvial plains'; riparian zone approximately 15 m on the left bank and 15 m on the right, comprising tall (15 m) open (25% crown cover) woodland dominated by yellowwood (*Terminalia oblongata*), silver-leaved ironbark (*E. melanophloia*) and poplar box (*E. populnea*), with occasional narrow-leaved bottletree (*Brachychiton rupestris*), Queensland blue gum (*Eucalyptus tereticornis*) and boonaree (*Alectryon oleifolius*); sparse sub-canopy with frequent white bauhinia (*Lysiphyllum hookeri*), occasional red bauhinia (*Lysiphyllum carronii*), sally wattle (*Acacia salicina*), brigalow (*A. harpophylla*), Nelia (*A. oswaldii*), false sandalwood (*Eremophila mitchellii*), warrior bush (*Apophyllum anomalum*) and limebush (*Citrus glauca*); sparse shrub layer with frequent soft turkey bush (*Acalypha eremorum*), occasional currant bush (*Carissa ovata*) and whitewood (*Atalaya hemiglauca*); ground layer dominated by buffel grass (*Cenchrus ciliaris*)*, with frequent mother-of-millions (*Bryophyllum delagoense*)*, brigalow burr (*Sclerolaena tetracuspis*), occasional Harrisia cactus (*Harrisia martinii*)* and velvet tree pear (Opuntia tomentosa)*; no macrophytes detected.

Erosion risk

Moderate-high – Banks appeared to be moderately unstable, with 25–49% of the streambank surfaces covered by vegetation (including tree roots).

Aquatic fauna, including breeding habitat

No aquatic fauna detected. May provide breeding and foraging habitat for fish in times of flow. No turtle or platypus breeding habitat detected.

Critically Endangered, Endangered, Vulnerable, Near Threatened (CEEVNT), Special Least Concern (SLC), or Priority flora and fauna

No CEEVNT, SLC or Priority aquatic flora or fauna species detected. The Critically Endangered (EPBC Act; Endangered – NC Act) southern snapping turtle (*Elseya albagula*) and Vulnerable (EPBC Act and NC Act) Fitzroy River turtle (*Rheodytes leukops*) are recorded from the Mackenzie River Sub-basin (DES 2020). However, the study reach does not provide suitable habitat for these species.

Table 11 **Two Mile Gully - Dry**

Site: R6	Property: Taurus	Stream order: 4	Latitude (GDA 94): -23.7309	Longitude (GDA 94): 148.8737	Date: 12/12/2019	Season: Dry

Physico-chemical water quality

Dry at the time of assessment.

Bioassessment scores

Habitat assessment score for dry season: Fair (53).

Overall aquatic values

Dry season: **Moderate**

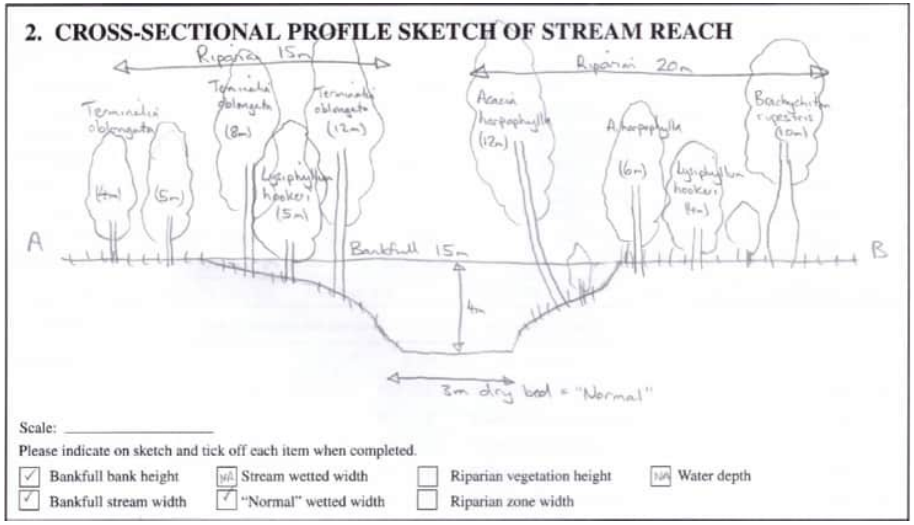


Table 12 **Two Mile Gully – Late wet**

Site: R6	Property: Taurus	Stream order: 4	Latitude (GDA 94): -23.7309	Longitude (GDA 94): 148.8737	Date: 21/05/2020	Season: Late wet

Upstream

Left bank

Downstream

Right bank

General Site Description

Site attributes

Ephemeral fourth order drainage line; debris indicates flood event since December 2019 survey, but dry at the time of assessment in May 2020; well defined bed and banks; little local catchment erosion, including bank slumping; convex banks, flat U shaped channel, as a result of sand deposition; sandy clay banks; banks moderately unstable (side slopes up to 60% on some banks); fair bank vegetative stability; bankfull width approx. 15 m and bankfull height approx. 4 m; in-stream habitat features in times of flow would include little (1–10%) detritus, sticks, branches and logs; bed substrates comprised approximately 2% pebble (4–64 mm), 40% gravel (2–4 mm) and 58% sand (0.05–2 mm); upstream and adjacent land use includes cattle grazing on land predominantly cleared of remnant vegetation.

Aquatic and riparian vegetation

Study reach positioned within riparian woodland State-mapped as non-remnant; field-verified as RE 11.3.2 – '*Eucalyptus populnea* woodland on alluvial plains'; riparian zone approximately 15 m on the left bank and 15 m on the right, comprising tall (15 m) open (25% crown cover) woodland dominated by yellowwood (*Terminalia oblongata*), silver-leaved ironbark (*E. melanophloia*) and poplar box (*E. populnea*), with occasional narrow-leaved bottletree (*Brachychiton rupestris*), Queensland blue gum (*Eucalyptus tereticornis*) and boonaree (*Alectryon oleifolius*); sparse sub-canopy with frequent white bauhinia (*Lysiphyllum hookeri*), occasional red bauhinia (*Lysiphyllum carronii*), sally wattle (*Acacia salicina*), brigalow (*A. harpophylla*), Nelia (*A. oswaldii*), false sandalwood (*Eremophila mitchellii*), warrior bush (*Apophyllum anomalum*) and limebush (*Citrus glauca*); sparse shrub layer with frequent soft turkey bush (*Acalypha eremorum*) and rubber vine (*Cryptostegia grandiflora*)*, occasional currant bush (*Carissa ovata*) and whitewood (*Atalaya hemiglauca*); ground layer dominated by buffel grass (*Cenchrus ciliaris*)*, with abundant parthenium (*Parthenium hysterophorus*)*, frequent mother-of-millions (*Bryophyllum delagoense*)*, brigalow burr (*Sclerolaena tetracuspis*), occasional Harrisia cactus (*Harrisia martinii*)* and velvet tree pear (Opuntia tomentosa)*; semi-aquatic macrophytes included little (1–10%) *Cyperus betchei* and white eclipta (*Eclipta prostrata*)*.

Erosion risk

Moderate-high – Banks appeared to be moderately unstable, with 25–49% of the streambank surfaces covered by vegetation (including tree roots).

Aquatic fauna, including breeding habitat

No aquatic fauna detected. May provide breeding and foraging habitat for fish in times of flow. No turtle or platypus breeding habitat detected.

Critically Endangered, Endangered, Vulnerable, Near Threatened (CEEVNT), Special Least Concern (SLC), or Priority flora and fauna

No CEEVNT, SLC or Priority aquatic flora or fauna species detected. The Critically Endangered (EPBC Act; Endangered – NC Act) southern snapping turtle (*Elseya albagula*) and Vulnerable (EPBC Act and NC Act) Fitzroy River turtle (*Rheodytes leukops*) are recorded from the Mackenzie River Sub-basin (DES 2020). However, the study reach does not provide suitable habitat for these species.

Table 12 **Two Mile Gully – Late wet**

Site: R6	Property: Taurus	Stream order: 4	Latitude (GDA 94): -23.7309	Longitude (GDA 94): 148.8737	Date: 21/05/2020	Season: Late wet

Physico-chemical water quality

Dry at the time of assessment.

Bioassessment scores

Habitat assessment score for dry season: Fair (53).

Overall aquatic values

Dry season: **Moderate**

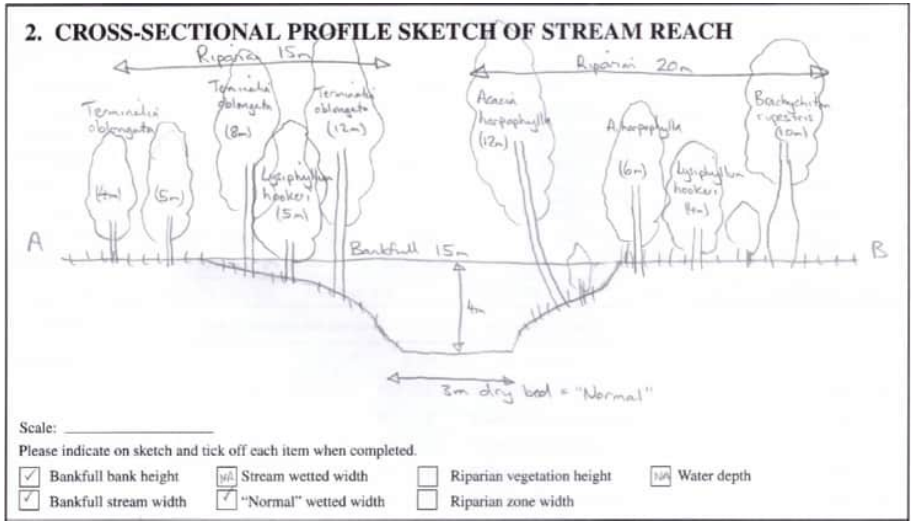


Table 13 **Taurus Creek – Dry**

Site: R7	Property: Mountain View	Stream order: 4	Latitude (GDA 94): -23.6717	Longitude (GDA 94): 148.8793	Date: 12/12/2019	Season: Dry

Upstream

Left bank

Downstream

Right bank

General Site Description

Site attributes

Ephemeral fourth order drainage line; dry at the time of assessment; well defined bed and banks; little local catchment erosion detected, including bank slumping; concave banks; U shaped channel; loamy clay banks; banks moderately stable, with infrequent small areas of erosion mostly healed over; bank vegetative stability fair; bankfull width approx. 19 m and bankfull height approx. 3 m; in-stream habitat features in times of flow would include some (10–50%) detritus, little (1–10%) sticks, branches and logs; bed substrates comprised approximately 5% bedrock, 10% boulder (>256 mm), 10% cobble (64–256 mm), 5% pebble (4–64 mm), 10% gravel (2–4 mm) and 55% sand and 5% silt/clay (<0.05 mm); upstream land use includes mining, moderate cattle grazing on land predominantly cleared of remnant vegetation, the Blackwater Rolleston Road and the Blackwater System rail; adjacent land use includes light cattle grazing.

Aquatic and riparian vegetation

Study reach positioned within riparian woodland State-mapped as non-remnant; field-verified as RE 11.3.3 – '*Eucalyptus coolabah* woodland on alluvial plains'; vegetation corridor approx. 180 m wide; riparian zone approximately 10 m on the left bank and 15 m on the right, comprising tall (18 m) open (35–40%) woodland dominated by coolabah (*Eucalyptus coolabah*), with occasional yellowwood (*Terminalia oblongata*), silver-leaved ironbark (*E. melanophloia*) and brigalow (*Acacia harpophylla*); sparse sub-canopy with frequent brigalow and yellowwood, and occasional wilga (*Geijera parviflora*); sparse shrub layer with occasional sally wattle (*Acacia salicina*), yellowwood, soft turkey bush (*Acalypha eremorum*) and currant bush (*Carissa ovata*); ground layer dominated by buffel grass (*Cenchrus ciliaris*)*, with frequent black speargrass (*Heteropogon contortus*), occasional curly windmill grass (*Enteropogon acicularis*), *Cyperus* sp. and umbrella canegrass (*Leptochloa digitata*); semi-aquatic macrophytes included little (1–10%) sedge (*Cyperus* sp.) and umbrella canegrass (*Leptochloa digitata*).

Erosion risk

Low-moderate – Banks appeared to be moderately stable, with 25–49% of the streambank surfaces covered by vegetation (including tree roots).

Aquatic fauna, including breeding habitat

No aquatic fauna detected. May provide breeding and foraging habitat for fish in times of flow. No turtle or platypus breeding habitat detected. Freshwater crab and mussel shells observed.

Critically Endangered, Endangered, Vulnerable, Near Threatened (CEEVNT), Special Least Concern (SLC), or Priority flora and fauna

No CEEVNT, SLC or Priority aquatic flora or fauna species detected. The Critically Endangered (EPBC Act; Endangered – NC Act) southern snapping turtle (*Elseya albagula*) and Vulnerable (EPBC Act and NC Act) Fitzroy River turtle (*Rheodytes leukops*) are recorded from the Mackenzie River Sub-basin (DES 2020). However, the study reach does not provide suitable habitat for these species.

Table 13 **Taurus Creek – Dry**

Site: R7	Property: Mountain View	Stream order: 4	Latitude (GDA 94): -23.6717	Longitude (GDA 94): 148.8793	Date: 12/12/2019	Season: Dry

Physico-chemical water quality

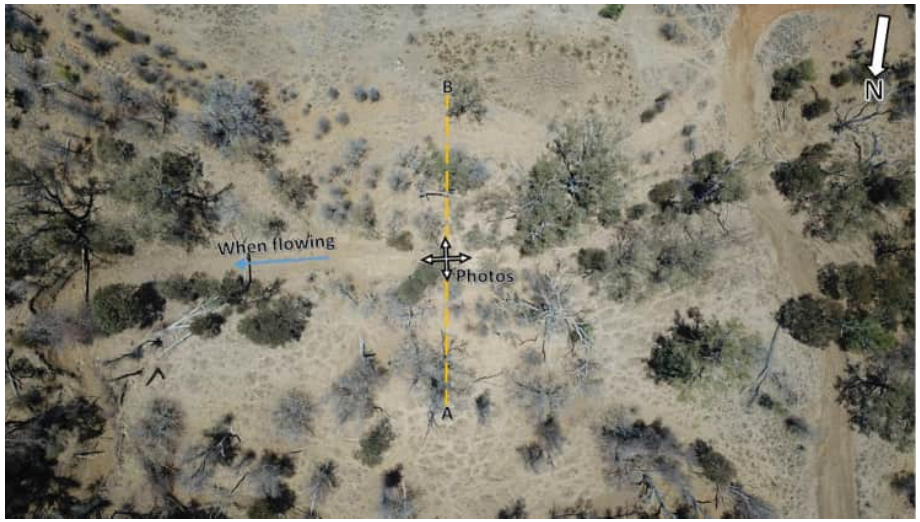
Dry at the time of assessment.

Bioassessment scores

Habitat assessment score for dry season: Fair (70).

Overall aquatic values

Dry season: **Moderate**



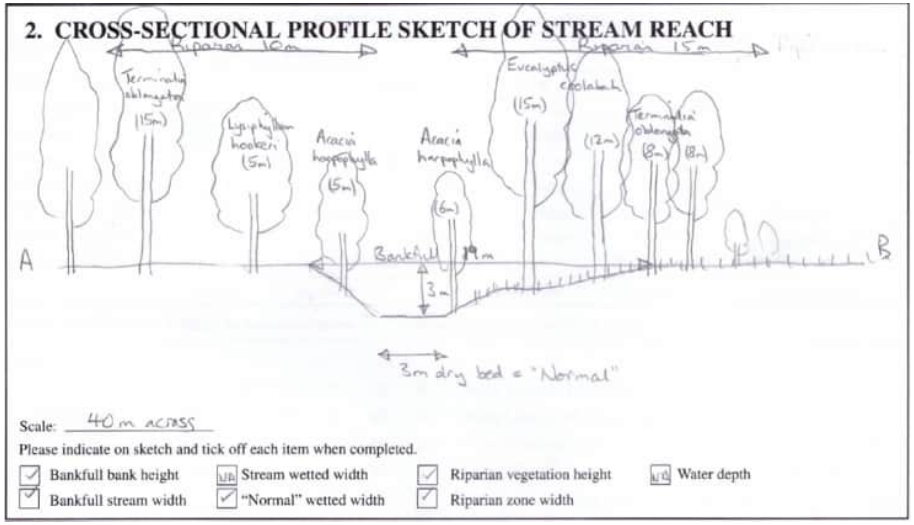


Table 14 **Taurus Creek – Late wet**

Site: R7	Property: Mountain View	Stream order: 4	Latitude (GDA 94): -23.6717	Longitude (GDA 94): 148.8793	Date: 20/05/2020	Season: Late wet

Upstream

Left bank

Downstream

Right bank

General Site Description

Site attributes

Ephemeral fourth order drainage line; debris indicates flood event since December 2019 survey, but dry at the time of assessment in May 2020; well defined bed and banks; little local catchment erosion detected, including bank slumping; concave banks; U shaped channel; loamy clay banks; banks moderately stable, with infrequent small areas of erosion mostly healed over; bank vegetative stability fair; bankfull width approx. 19 m and bankfull height approx. 3 m; in-stream habitat features in times of flow would include some (10–50%) detritus, little (1–10%) sticks, branches and logs; bed substrates comprised approximately 5% bedrock, 10% boulder (>256 mm), 10% cobble (64–256 mm), 5% pebble (4–64 mm), 10% gravel (2–4 mm) and 55% sand and 5% silt/clay (<0.05 mm); upstream land use includes mining, moderate cattle grazing on land predominantly cleared of remnant vegetation, the Blackwater Rolleston Road and the Blackwater System rail; adjacent land use includes light cattle grazing.

Aquatic and riparian vegetation

Study reach positioned within riparian woodland State-mapped as non-remnant; field-verified as RE 11.3.3 – '*Eucalyptus coolabah* woodland on alluvial plains'; vegetation corridor approx. 180 m wide; riparian zone approximately 10 m on the left bank and 15 m on the right, comprising tall (18 m) open (35–40%) woodland dominated by coolabah (*Eucalyptus coolabah*), with occasional yellowwood (*Terminalia oblongata*), silver-leaved ironbark (*E. melanophloia*) and brigalow (*Acacia harpophylla*); sparse sub-canopy with frequent brigalow and yellowwood, and occasional wilga (*Geijera parviflora*); sparse shrub layer with occasional sally wattle (*Acacia salicina*), yellowwood, soft turkey bush (*Acalypha eremorum*) and currant bush (*Carissa ovata*); ground layer dominated by buffel grass (*Cenchrus ciliaris*)*, with frequent black speargrass (*Heteropogon contortus*), occasional parthenium (*Parthenium hysterophorus*)*, curly windmill grass (*Enteropogon acicularis*), *Cyperus betchei* and umbrella canegrass (*Leptochloa digitata*); semi-aquatic macrophytes included little (1–10%) *C. betchei*, *C. concinnus* and umbrella canegrass.

Erosion risk

Low-moderate – Banks appeared to be moderately stable, with 25–49% of the streambank surfaces covered by vegetation (including tree roots).

Aquatic fauna, including breeding habitat

No aquatic fauna detected. May provide breeding and foraging habitat for fish in times of flow. No turtle or platypus breeding habitat detected. Freshwater crab and mussel shells observed.

Critically Endangered, Endangered, Vulnerable, Near Threatened (CEEVNT), Special Least Concern (SLC), or Priority flora and fauna

No CEEVNT, SLC or Priority aquatic flora or fauna species detected. The Critically Endangered (EPBC Act; Endangered – NC Act) southern snapping turtle (*Elseya albagula*) and Vulnerable (EPBC Act and NC Act) Fitzroy River turtle (*Rheodytes leukops*) are recorded from the Mackenzie River Sub-basin (DES 2020). However, the study reach does not provide suitable habitat for these species.

Table 14 **Taurus Creek – Late wet**

Site: R7	Property: Mountain View	Stream order: 4	Latitude (GDA 94): -23.6717	Longitude (GDA 94): 148.8793	Date: 20/05/2020	Season: Late wet

Physico-chemical water quality

Dry at the time of assessment.

Bioassessment scores

Habitat assessment score for dry season: Fair (70).

Overall aquatic values

Dry season: **Moderate**

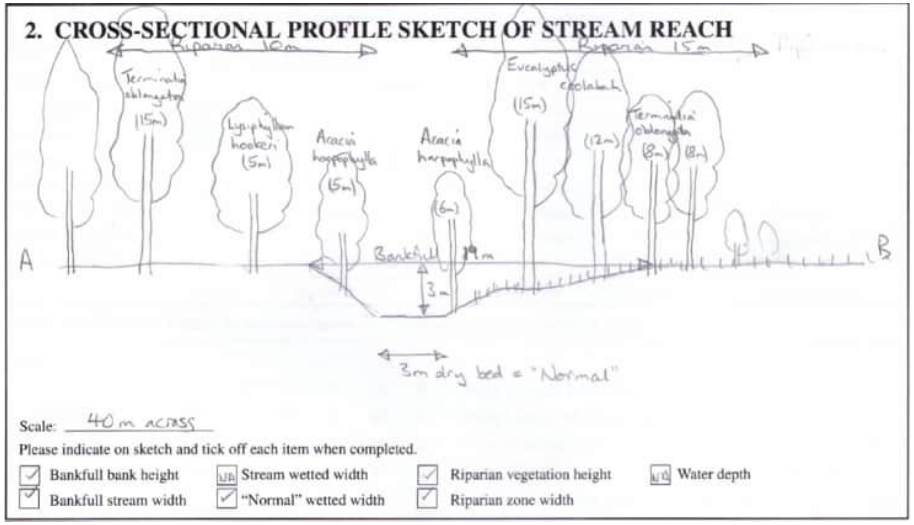


Table 15 **Flood-channel on Taurus Creek – Late wet**

Site: RW1	Property: Mountain View	Stream order: 3	Latitude (GDA 94): -23.6954	Longitude (GDA 94): 148.8653	Date: 21/05/2020	Season: Late wet

Upstream

Left bank

Downstream

Right bank

General Site Description

Site attributes

Flood channel on third order Taurus Creek; dry at the time of aerial (drone) assessment in December 2019; large isolated pool at the time of assessment in May 2020; well defined bed and banks; little local catchment erosion detected, including rill erosion; concave banks; U shaped channel; loamy clay banks; banks moderately stable, with infrequent small areas of erosion mostly healed over; bank vegetative stability fair; bankfull width approx. 18 m and bankfull height approx. 2.3 m; in-stream habitat features include little (1–10%) detritus, sticks, branches and logs; bed substrates comprised 100% silt/clay (<0.05 mm); edge substrates comprised 5% sand (0.5–2 mm) and 95% silt/clay; upstream land use includes mining and moderate cattle grazing on land predominantly cleared of remnant vegetation; adjacent land use includes light cattle grazing.

Aquatic and riparian vegetation

Study reach positioned within riparian woodland State-mapped as non-remnant; field-verified as RE 11.3.1 / 11.3.27b – '*Acacia harpophylla* and/or *Casuarina cristata* open forest on alluvial plains' / 'Lacustrine wetland'; riparian zone approximately 10 m on the left bank and 10 m on the right, comprising tall (18 m) open (35–40%) woodland dominated by Queensland blue gum (*Eucalyptus tereticornis*) – both alive and dead (stags), with frequent brigalow (*Acacia harpophylla*) and yellowwood (*Terminalia oblongata*); sparse sub-canopy with frequent white bauhinia (*Lysiphyllum hookeri*), ironwood (*Acacia excelsa*) and occasional sally wattle (*Acacia salicina*); sparse shrub layer, including native cocaine (*Erythroxylum australe*), whitewood (*Atalaya hemiglauca*), mimosa bush (*Vachellia farnesiana*)* and velvet tree pear (*Opuntia tomentosa*)*; ground layer dominated by buffel grass (*Cenchrus ciliaris*)* and green panic (*Megathyrsus maximus*)*; semi-aquatic macrophytes included little (1–10%) dwarf sedge (*Cyperus pygmaeus*).

Erosion risk

Low-moderate – Banks appeared to be moderately stable, with 25–49% of the streambank surfaces covered by vegetation (including tree roots).

Aquatic fauna, including breeding habitat

The reach provides potential foraging and breeding habitat for fish and common turtle species. No suitable platypus breeding habitat detected. Aquatic fauna detected by backpack electrofishing and overnight deployment of two baited fyke nets and five baited box traps included gudgeon (*Hypseleotris galii* / sp. 1), eastern rainbowfish (*Melanotaenia splendida*), Agassiz's glassfish (*Ambassis agassizii*), spangled perch (*Leiopotherapon unicolor*), bony bream (*Nematalosa erebi*), purple-spotted gudgeon (*Mogurnda adspersa*), Rendahl's catfish (*Porochilus rendahli*) and Hyrtyl's tandan (*Neosilurus hyrtlii*).

Table 15 **Flood-channel on Taurus Creek – Late wet**

Site: RW1	Property: Mountain View	Stream order: 3	Latitude (GDA 94): -23.6954	Longitude (GDA 94): 148.8653	Date: 21/05/2020	Season: Late wet

Critically Endangered, Endangered, Vulnerable, Near Threatened (CEEVNT), Special Least Concern (SLC), or Priority flora and fauna

No CEEVNT, SLC or Priority aquatic flora or fauna species detected. The Critically Endangered (EPBC Act; Endangered – NC Act) southern snapping turtle (*Elseya albagula*) and Vulnerable (EPBC Act and NC Act) Fitzroy River turtle (*Rheodytes leukops*) are recorded from the Mackenzie River Sub-basin (DES 2020). However, the study reach does not provide suitable habitat for these species.

Physico-chemical water quality

Collection time: 13:45; water temp.: 20.0˚C; specific conductivity: 573 µS/cm (fresh); turbidity: 27 NTU (good clarity); dissolved oxygen: 89.0%, 8.1 (normal); pH: 8.6 (strongly alkaline, likely reflecting the clay-rich catchment). Comments: Normal.

Bioassessment scores

Habitat assessment score for dry season: Fair (57).

Overall aquatic values

Dry season: **Moderate**

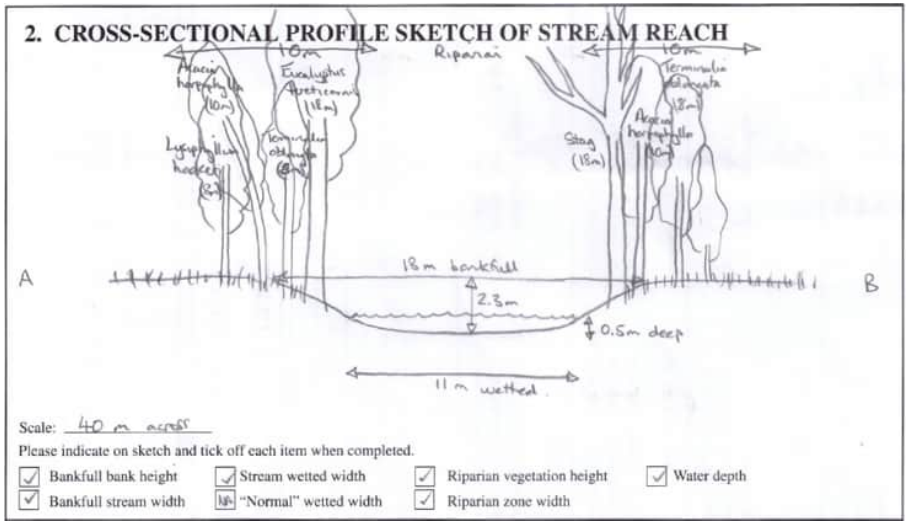


Table16 **Lacustrine wetland waterbody – Dry**

Site: L1	Property: Mountain View	Stream order: 2	Latitude (GDA 94): -23.6417	Longitude (GDA 94): 148.8591	Date: 10/12/2019	Season: Dry

Vertical (from 100 magl)

Left bank

Downstream

Right bank

General Site Description

Site attributes

Small unmapped lacustrine waterbody (farm dam) on Sagittarius Creek; approx. 0.25 ha; little local catchment erosion, including rilling; >1.5 m deep; clay banks; in-stream habitat included shallow (<0.5 m) pool, deep pool and macrophytes; bed substrates comprised 100% silt/clay (<0.05 mm); upstream and adjacent land use includes moderate cattle grazing on land predominantly cleared of native vegetation.

Aquatic and riparian vegetation

Assessment site positioned within agricultural grassland State-mapped as non-remnant in the RE mapping; field-verified as non-remnant; fringing vegetation included a low (4–5 m) sparse (15%) tree layer dominated by brigalow (*Acacia harpophylla*), with occasional red bauhinia (*Lysiphyllum carronii*), whitewood (*Atalaya hemiglauca*), sally wattle (*Acacia salicina*) and yellowwood (*Terminalia oblongata*); very sparse shrub layer including currant bush (*Carissa ovata*) and warrior bush (*Apophyllum anomalum*); ground layer dominated by buffel grass (*Cenchrus ciliaris*)*, with frequent bluegrass (*Bothriochloa* sp.) and occasional Harrisia cactus (*Harrisia martinii*)*; submerged macrophytes included moderate (50–75%) cover of curly pondweed (*Potamogeton crispus*) and little (1–10%) swamp lily (*Ottelia ovalifolia*); emergent macrophytes included moderate (50–75%) cover of smartweed (*Persicaria attenuata*) and some (10–50%) cumbungi (*Typha domingensis*); fringing macrophytes included little (1–10%) umbrella canegrass (*Leptochloa digitata*), willow primrose (*Ludwigia octovalvis*) and dwarf sedge (*Cyperus pygmaeus*).

Aquatic fauna, including breeding habitat

The waterbody provides potential foraging and breeding habitat for fish and common turtle species. No suitable platypus breeding habitat detected. Aquatic fauna detected by backpack electrofishing and overnight deployment of two baited fyke nets and five baited box traps included gudgeon (*Hypseleotris galii* / sp. 1), western carp gudgeon (*H. klunzingeri*), eastern rainbowfish (*Melanotaenia splendida*), Rendahl's tandan (*Porochilus rendahli*), Hyrtl's tandan (*Neosilurus hyrtlii*), Agassiz's glassfish (*Ambassis agassizii*), spangled perch (*Leiopotherapon unicolor*), bony bream (*Nematalosa erebi*), purple-spotted gudgeon (*Mogurnda adspersa*), mosquitofish (*Gambusia holbrooki*)* and eastern snake-necked turtle (*Chelodina longicollis*).

Critically Endangered, Endangered, Vulnerable, Near Threatened (CEEVNT), Special Least Concern (SLC), or Priority flora and fauna

No CEEVNT, SLC or Priority aquatic flora or fauna species detected. The Critically Endangered (EPBC Act; Endangered – NC Act) southern snapping turtle (*Elseya albagula*) and Vulnerable (EPBC Act and NC Act) Fitzroy River turtle (*Rheodytes leukops*) are recorded from the Mackenzie River Sub-basin (DES 2020). However, the waterbody does not provide suitable habitat for these species.

Table16 **Lacustrine wetland waterbody – Dry**

Site: L1	Property: Mountain View	Stream order: 2	Latitude (GDA 94): -23.6417	Longitude (GDA 94): 148.8591	Date: 10/12/2019	Season: Dry

Physico-chemical water quality

Collection time: 11:30; water temp.: 26.9˚C; specific conductivity: 437 µS/cm (fresh); turbidity: 40 NTU (good clarity); dissolved oxygen: 76.0%, 5.7 mg/L (relatively low for time of day when DO levels should be nearing their diurnal peak); pH: 8.6 (strongly alkaline, reflecting the clay catchment). Comments: Most parameters normal; relatively low DO likely due to oxygen consumption by bacteria during the breakdown of organic matter.

Overall aquatic values

Dry season: **Moderate**

Table 17 Lacustrine wetland waterbody – Late wet

Site: L1	Property: Mountain View	Stream order: 2	Latitude (GDA 94): -23.6417	Longitude (GDA 94): 148.8591	Date: 19/05/2020	Season: Late wet

Upstream

Left bank

Downstream

Right bank

General Site Description

Site attributes

Small unmapped lacustrine waterbody (farm dam) on Sagittarius Creek; 0.25 ha; little local catchment erosion, including rill erosion; >1.5 m deep; clay banks; in-stream habitat included shallow (<0.5 m) pool, deep pool and macrophytes; bed substrates comprised 100% silt/clay (<0.05 mm); upstream and adjacent land use includes moderate cattle grazing on land predominantly cleared of native vegetation.

Aquatic and riparian vegetation

Assessment site positioned within agricultural grassland State-mapped as non-remnant in the RE mapping; field-verified as non-remnant; fringing vegetation included a low (4–5 m) sparse (15%) tree layer dominated by brigalow (*Acacia harpophylla*), with occasional red bauhinia (*Lysiphyllum carronii*), whitewood (*Atalaya hemiglauca*), sally wattle (*Acacia salicina*) and yellowwood (*Terminalia oblongata*); very sparse shrub layer including currant bush (*Carissa ovata*) and warrior bush (*Apophyllum anomalum*); ground layer dominated by buffel grass (*Cenchrus ciliaris*)*, with frequent bluegrass (*Bothriochloa* sp.) and occasional Harrisia cactus (*Harrisia martinii*)*; submerged macrophytes included moderate (50–75%) cover of curly pondweed (*Potamogeton crispus*) and little (1–10%) swamp lily (*Ottelia ovalifolia*); emergent macrophytes included moderate (50–75%) cover of cumbungi (*Typha domingensis*); fringing macrophytes included little (1–10%) *Cyperus betchei*, *C. concinnus*, rice sedge (*C. difformis*), tall flatsedge (*C. exaltatus*), dwarf sedge (*C. pygmaeus*), pale knotweed (*Persicaria lapathifolia*), umbrella canegrass (*Leptochloa digitata*), willow primrose (*Ludwigia octovalvis*), water primrose (*L. peploides*), brown beetle grass (*Diplachne fusca fusca*), white eclipta (*Eclipta prostrata*)*.

Aquatic fauna, including breeding habitat

The waterbody provides potential foraging and breeding habitat for fish and common turtle species. No suitable platypus breeding habitat detected. Aquatic fauna detected by backpack electrofishing and overnight deployment of two baited fyke nets and five baited box traps included gudgeon (*Hypseleotris galii* / sp. 1), eastern rainbowfish (*Melanotaenia splendida*), Rendahl's tandan (*Porochilus rendahli*), Hyrtl's tandan (*Neosilurus hyrtlii*), Agassiz's glassfish (*Ambassis agassizii*), spangled perch (*Leiopotherapon unicolor*), bony bream (*Nematalosa erebi*), purple-spotted gudgeon (*Mogurnda adspersa*), mosquitofish (*Gambusia holbrooki*)*.

Critically Endangered, Endangered, Vulnerable, Near Threatened (CEEVNT), Special Least Concern (SLC), or Priority flora and fauna

No CEEVNT, SLC or Priority aquatic flora or fauna species detected. The Critically Endangered (EPBC Act; Endangered – NC Act) southern snapping turtle (*Elseya albagula*) and Vulnerable (EPBC Act and NC Act) Fitzroy River turtle (*Rheodytes leukops*) are recorded from the Mackenzie River Sub-basin (DES 2020). However, the waterbody does not provide suitable habitat for these species.

Table 17 Lacustrine wetland waterbody – Late wet

Site: L1	Property: Mountain View	Stream order: 2	Latitude (GDA 94): -23.6417	Longitude (GDA 94): 148.8591	Date: 19/05/2020	Season: Late wet

Physico-chemical water quality

Collection time: 12:00; water temp.: 19.1˚C; specific conductivity: 414 µS/cm (fresh); turbidity: 41 NTU (good clarity); dissolved oxygen: 75.1%, 6.9 mg/L (relatively low for time of day when DO levels should be nearing their diurnal peak); pH: 7.8 (mildly alkaline, reflecting the clay-rich catchment). Comments: Parameters normal; relatively low DO likely due to oxygen consumption by bacteria during the breakdown of organic matter, including decomposing smartweed (*Persicaria attenuata*) inundated since the December 2019 survey.

Overall aquatic values

Dry season: **Moderate**

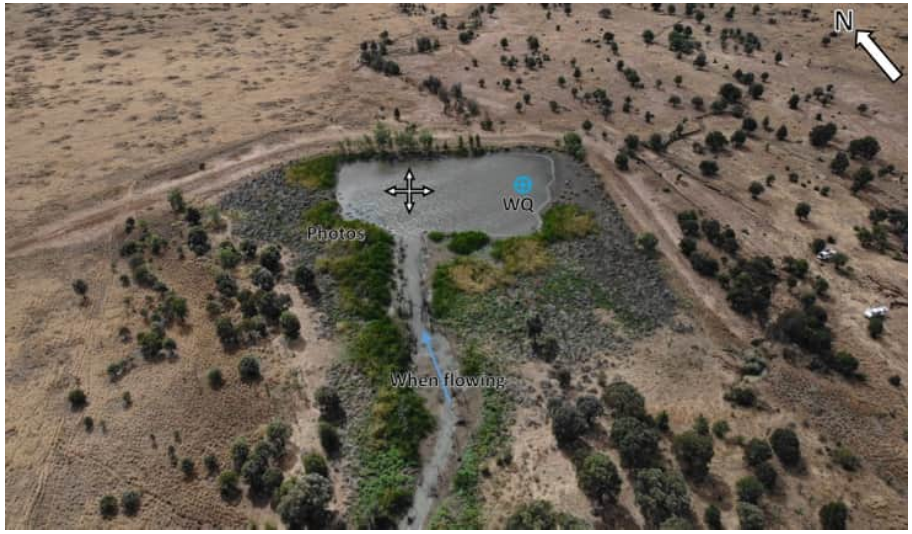


Table 18 Lacustrine wetland waterbody – Dry

Site: L2	Property: Taurus	Stream order: 1	Latitude (GDA 94): -23.7142	Longitude (GDA 94): 148.8777	Date: 12/12/2019	Season: Dry

Upstream

Left bank

Downstream

Right bank

General Site Description

Site attributes

Approximate 1.5 ha mapped lacustrine waterbody (farm dam) on a first order tributary of Two Mile Gully, and subsequently Taurus Creek; no local catchment erosion detected; clay banks; in-stream habitat included shallow (<0.5 m) pool, deep pool and macrophytes; bed substrates comprised 100% silt/clay (<0.05 mm); upstream land use dominated by a Coal Handling and Processing Facility (CHPP) ; adjacent land use includes moderate cattle grazing on land predominantly cleared of native vegetation.

Aquatic and riparian vegetation

Waterbody positioned within agricultural grassland State-mapped as non-remnant; field-verified as non-remnant; waterbody mapped as lacustrine waterbody in the Queensland Wetlands Mapping; fringing vegetation included a tall (15 m) very sparse (10%) tree layer dominated by poplar box (*Eucalyptus populnea*), with frequent brigalow (*Acacia harpophylla*) and sally wattle (*Acacia salicina*); sparse sub-canopy with frequent sally wattle, boonaree (*Alectryon oleifolius*), dead finish (*Archidendropsis basaltica*), occasional wilga (*Geijera parviflora*), *Elaeodendron 35ttenua*, bean tree (*Cassia brewsteri*) and small-leaved ebony (*Diospyros humilis*); very sparse shrub layer, including currant bush (*Carissa ovata*), limebush (*Citrus glauca*), nipan (*Capparis lasiantha*) and bumble tree (*Capparis mitchellii*); ground layer dominated by buffel grass (*Cenchrus ciliaris*)*, with abundant common couch (*Cynodon dactylon*)*, frequent water primrose (*Ludwigia peploides*), small knotweed (*Polygonum plebeium*), occasional umbrella canegrass (*Leptochloa digitata*) and *Cyperus* sp.; emergent macrophytes included some (10–50%) cumbungi (*Typha domingensis*) and water primrose, little (1–10%) smartweed (*Persicaria attenuata*), slender knotweed (*P. decipiens*) and *Nymphoides* sp. (not flowering); fringing macrophytes included little (1–10%) umbrella canegrass, rice sedge (*Cyperus difformis*), *Cyperus* sp. (heavily grazed) and common rush (*Juncus usitatus*).

Aquatic fauna, including breeding habitat

The waterbody provides potential foraging and breeding habitat for fish, water birds and common turtle species. No suitable platypus breeding habitat detected. No fish or turtle survey undertaken (habitat assessment only).

Critically Endangered, Endangered, Vulnerable, Near Threatened (CEEVNT), Special Least Concern (SLC), or Priority flora and fauna

No CEEVNT, SLC or Priority aquatic flora or fauna species detected. The Critically Endangered (EPBC Act; Endangered – NC Act) southern snapping turtle (*Elseya albagula*) and Vulnerable (EPBC Act and NC Act) Fitzroy River turtle (*Rheodytes leukops*) are recorded from the Mackenzie River Sub-basin (DES 2020). However, the waterbody does not provide suitable habitat for these species.

Table 18 **Lacustrine wetland waterbody – Dry**

Site: L2	Property: Taurus	Stream order: 1	Latitude (GDA 94): -23.7142	Longitude (GDA 94): 148.8777	Date: 12/12/2019	Season: Dry

Physico-chemical water quality

Collection time: 10:20; water temp.: 30.1˚C; specific conductivity: 595 µS/cm (fresh); turbidity: 31 NTU (good clarity); dissolved oxygen: 87.9%, 6.6 mg/L (normal); pH: 8.1 (moderately alkaline), reflecting the clay catchment. Comments: Normal.

Overall aquatic values

Dry season: **Moderate**

Table 19 Lacustrine wetland waterbody – Late wet

Site: L2	Property: Taurus	Stream order: 1	Latitude (GDA 94): -23.7142	Longitude (GDA 94): 148.8777	Date: 21/05/2020	Season: Dry

Upstream

Left bank

Downstream

Right bank

General Site Description

Site attributes

Approximate 1.5 ha mapped lacustrine waterbody (farm dam) on a first order tributary of Two Mile Gully, and subsequently Taurus Creek; the farm dam is located downstream of the Cook Colliery Coal Handling and Processing Facility (CHPP); in-stream habitat included shallow (<0.5 m) pool, deep pool and macrophytes; adjacent land use includes moderate cattle grazing on land predominantly cleared of native vegetation. Bed substrate noted to display coal fines.

Aquatic and riparian vegetation

Wetland waterbody positioned within agricultural grassland State-mapped as non-remnant; field-verified as non-remnant; waterbody mapped as lacustrine waterbody in the Queensland Wetlands Mapping; fringing vegetation included a tall (15 m) very sparse (10%) tree layer dominated by poplar box (*Eucalyptus populnea*), with frequent brigalow (*Acacia harpophylla*) and sally wattle (*Acacia salicina*); sparse sub-canopy with frequent sally wattle, boonaree (*Alectryon oleifolius*), dead finish (*Archidendropsis basaltica*), occasional wilga (*Geijera parviflora*), *Elaeodendron australe*, bean tree (*Cassia brewsteri*) and small-leaved ebony (*Diospyros humilis*); very sparse shrub layer, including currant bush (*Carissa ovata*), limebush (*Citrus glauca*), nipan (*Capparis lasiantha*) and bumble tree (*Capparis mitchellii*); ground layer dominated by buffel grass (*Cenchrus ciliaris*)*, with abundant common couch (*Cynodon dactylon*)*, occasional water primrose (*Ludwigia peploides*), small knotweed (*Polygonum plebeium*), umbrella canegrass (*Leptochloa digitata*) and *Cyperus* sp.; emergent macrophytes included moderate (50–75%) cover of water snowflake (*Nymphoides indica*), some (10–50%) cumbungi (*Typha domingensis*) and little (1–10%) water primrose; fringing macrophytes included little (1–10%) willow primrose (*Ludwigia octovalvis*), white eclipta (*Eclipta prostrata*)*, umbrella canegrass, rice sedge (*Cyperus difformis*), *Cyperus* sp. (grazed) and common rush (*Juncus usitatus*).

Aquatic fauna, including breeding habitat

The waterbody provides potential foraging and breeding habitat for fish, water birds and common turtle species. No suitable platypus breeding habitat detected. No fish or turtle survey undertaken (habitat assessment only).

Critically Endangered, Endangered, Vulnerable, Near Threatened (CEEVNT), Special Least Concern (SLC), or Priority flora and fauna

No CEEVNT, SLC or Priority aquatic flora or fauna species detected. The Critically Endangered (EPBC Act; Endangered – NC Act) southern snapping turtle (*Elseya albagula*) and Vulnerable (EPBC Act and NC Act) Fitzroy River turtle (*Rheodytes leukops*) are recorded from the Mackenzie River Sub-basin (DES 2020). However, the waterbody does not provide suitable habitat for these species.

Table 19 Lacustrine wetland waterbody – Late wet

Site: L2	Property: Taurus	Stream order: 1	Latitude (GDA 94): -23.7142	Longitude (GDA 94): 148.8777	Date: 21/05/2020	Season: Dry

Physico-chemical water quality

Collection time: 12:10; water temp.: 19.7˚C; specific conductivity: 2,401 µS/cm (brackish); turbidity: 23.5 NTU (high clarity); dissolved oxygen: 66.0%, 5.98 mg/L (low for time of day); pH: 7.9 (moderately alkaline). Comments: Downstream of Cook Colliery CHPP.

Overall aquatic values

Dry season: **Moderate**

Australia

SYDNEY
Ground floor, 20 Chandos Street
St Leonards NSW 2065
T 02 9493 9500

NEWCASTLE
Level 3, 175 Scott Street
Newcastle NSW 2300
T 02 4907 4800

BRISBANE
Level 1, 87 Wickham Terrace
Spring Hill QLD 4000
T 07 3648 1200

CANBERRA
Level 2, Suite 2.04
15 London Circuit
Canberra City ACT 2601

ADELAIDE
Level 4, 74 Pirie Street
Adelaide SA 5000
T 08 8232 2253

MELBOURNE
188 Normanby Road
Southbank VIC 3006

PERTH
Level 9, Suite 9.02
109 St Georges Terrace
Perth WA 6831

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TORONTO
2345 Yonge Street, Suite 300
Toronto ON M4P 2E5

VANCOUVER
60 W 6th Ave Suite 200
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Attachment B Stygofauna Assessment (Freshwater Ecology 2021)

BM Alliance Coal Operations Pty Ltd (BMA)
Blackwater Mine

Stygofauna Pilot Survey

Prepared for ALS Rockhampton
June 2021
Final Report

Document Control Summary

Document Revisions

Project Title		BMA Blackwater Mine Stygofauna Assessment			
Project Manager		Dr Timothy Howell			
Document Title		FE20043_BlackwaterStygo2021			
Electronic File Name	**Status**	**Prepared by**	**Reviewed by**	**Authorised**	**Date**
FE20043_BlackwaterStygo2021_V1	Draft	Garry Bennison	Timothy Howell	Timothy Howell	23/6/21
FE20043_BlackwaterStygo2021_FINAL	Final	Garry Bennison	Timothy Howell	Timothy Howell	7/7/21

Document Distribution

Electronic File Name	**Status**	**Issued to**	**Format**	**Issued by**
FE20043_BlackwaterStygo2021_V1	Draft	Denver O'Grady	MS word	Timothy Howell
FE20043_BlackwaterStygo2021_FINAL	Final	Denver O'Grady	MS word	Timothy Howell

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1. Introduction

The Blackwater Mine is located approximately 25 kilometres (km) south of Blackwater in Central Queensland. Blackwater Mine is owned and operated by BM Alliance Coal Operations Pty Ltd (BMA).

BMA are proposing to extend mining operations on mining lease (ML) 1759 (Surface Area 10) and on ML 1762 (Surface Area 7), located adjacent (to the northeast) to the existing Blackwater Mine.

Freshwater Ecology Pty Ltd (Freshwater Ecology) were engaged to undertake a stygofauna pilot survey for the Blackwater Mine northern extension area 2020. Two field sampling events have been conducted as part of the pilot survey in November 2020 and May 2021.

This report constitutes the final report for the BMA stygofauna pilot survey and integrates data across both sampling events.

2. General Terminology

In Australia, Groundwater Dependent Ecosystems (GDE's) are defined as 'ecosystems which require access to groundwater on a permanent or intermittent basis to meet all or some of their water requirements so as to maintain their communities of plants and animals, ecological processes and ecosystem services' (Richardson *et al.* 2011). Not all GDE's draw on groundwater directly and not all GDE's are solely reliant on groundwater.

Six types of Groundwater Dependent Ecosystems have been identified in Australia:

- Terrestrial vegetation that relies on the availability of shallow groundwater.
- Wetlands such as paperbark swamp forests and mound springs.
- River baseflow systems where groundwater discharge provides a significant baseflow component to the river.
- Aquifer and cave ecosystems where life exists independent of sunlight (this GDE contains stygofauna and is the focus of the current survey).
- Terrestrial fauna species, both native and introduced, that rely on groundwater as a source of drinking water.
- Estuarine and near-shore marine systems, such as coastal mangroves, salt marshes and sea-grass beds, which rely on the submarine discharge of groundwater.

Until recently, aquifers were considered to be devoid of life, however, recent research in Australia and overseas has highlighted the fact that groundwater systems provide a critical habitat for a diverse range of aquatic fauna called stygofauna (Hose *et al.* 2015; Glanville *et al.* 2016). The term stygofauna encompasses;

- Stygobionts (stygobites) which are defined as being organisms that are obligate groundwater inhabitants for some or all of their life (Sket 2008),
- Stygophiles which are defined as surface-dwelling species that complete some or all of their life cycle in groundwater (Sket 2008), and
- Stygoxenes which are defined as animals found accidentally in groundwater (Sket 2008).

Typically, it is the stygobionts and stygophiles that are referred to collectively as stygofauna (Hose *et al.* 2015) and these definitions will be adopted for this BMA survey.

Section 3 of this report provides a background summary of stygofauna, their ecological requirements, their taxonomic diversity and potential impacts from mining on groundwater ecosystems and stygofaunal communities.

3. What are Stygofauna?

Stygofauna are aquatic subterranean animals that are totally groundwater dependent (stygobites) and found throughout Australian aquifers. Groundwater ecology surveys and studies over the past 20 years in Australia have identified a diverse range of organisms inhabiting groundwater systems, however, whilst the groundwater ecosystem is diverse and unique, this ecosystem is probably the least studied globally. Tomlinson *et al.* (2008) noted that stygofauna are valued as a biodiversity resource, as indicators of groundwater ecosystem health and potential providers of ecosystem services including, nutrient cycling and storage, organic matter cycling and redistribution, water treatment, maintenance of groundwater flow and mineral weathering and formation.

Stygofauna are morphologically and physiologically different from even closely related surface-dwelling species having independently evolved common morphological traits such as lacking eyes, having hardened body parts, lacking body pigments and having worm-like body shapes and enhanced sensory appendages as an adaption to the groundwater environment (Humphreys 2006). Stygofauna in Australia include both microfauna such as Turbellaria, Rotifera, Nematode and Protozoa (Humphreys 2006) as well as larger meiofauna that are generally dominated by crustaceans but may include insects, nematodes, molluscs, oligochaetes and mites. The crustaceans include Copepoda, Syncarida, Amphipoda, Isopoda and Ostracoda (all of which have surface dwelling relatives) as well as groups only found in groundwater such as Remipedia, Thermosbanacea and Speleaogriphacea. Insects are relatively uncommon in groundwater (Humphreys 2006) although diverse coleopteran assemblages have been recorded in some parts of Australia (Watts *et al.* 2007). The diversity of stygofauna in Australia is comparable to that of other regions of the world.

Stygofauna are adapted to groundwater environments and conditions of constant temperature, no sunlight, low nutrients and oxygen content, stable water quality and sediments that provide a limited and narrow pore space (Hose *et al.* 2015). Stygofauna have low metabolic rates and low reproductive rates relative to surface species which enables them to survive in the low energy, low oxygen groundwater environment. Groundwater ecosystems typically have few stygobiont species at any one locality and consequently low diversity. However, the isolation of aquifers and limited dispersal abilities of groundwater organisms has created a fauna dominated by short-range endemic species (Harvey 2002). As stygofauna are adapted to a stable physical and chemical subterranean environment and as species often exhibit narrow geographic ranges, even slight alterations to the groundwater environment (i.e. flow, flux, pressure, level, quality and the transport of nutrients and organic matter) can result in significant changes to the composition and distribution of stygofauna communities and even the potential loss of species. The major pressures on groundwater systems in Queensland, as elsewhere, are from anthropogenic

activities (i.e. agriculture, industry and domestic water supply) that modify aspects of the groundwater environment and impact on groundwater quantity and quality. The pressures on groundwater ecosystems are also cumulative (Danielopol *et al.* 2003).

3.1 Ecological Requirements of Stygofauna

Twenty years ago it was believed that stygofauna only existed within a very narrow physico-chemical parameter range. More recent surveys and studies have shown that this is not the case and that stygofauna may be found across a more diverse physico-chemical range of groundwater systems than was previously commonly assumed. Only recently has the true biological diversity of aquifers begun to emerge, both in Australia and globally.

In 2016, Glanville *et al.*, reviewed a state-wide database which included 755 stygofauna samples from 582 sites in Queensland and the current knowledge on stygofauna biodiversity and biogeography. This study correlated stygofauna discovery against environmental data and reported the following important outcomes:

- Groundwater with a wide range of physico-chemical properties have been recorded as supporting groundwater ecosystems in Queensland.
- Stygofauna have been recorded living in groundwater ranging in depth from 0.1 to 63.2 metres below ground level; electrical conductivity ranging from 11.5 to 54,800 µS/cm; groundwater temperatures ranging from 17.0 to 30.7ºC, and groundwater pH ranging from 3.5 to 10.3.
- Stygofauna taxon richness shows a general negative trend with increasing depth to groundwater or electrical conductivity (salinity).
- Taxon richness is highest in neutral to slightly alkaline pH groundwater systems and in water temperatures between 18 and 27ºC.
- Taxon richness was shown to decrease sharply with increasing groundwater acidity and alkalinity.

It was acknowledged that the stygofauna preferences identified from the Queensland database may partially reflect the limited sampling effort that has occurred across physico-chemically diverse groundwater systems and that the data was predominantly from sites sampled only once.

Hose *et al.* (2015) also noted a number of key factors determining the presence/absence of stygofauna in aquifers:

- Stygofauna are predominantly found in aquifers with large (mm or greater) pore spaces which are more common in alluvial, karstic and some fractured rock aquifers. The pore spaces within an aquifer matrix are a critical determinant of whether an aquifer can support large-bodied organisms as stygofauna move within an aquifer by either crawling

or swimming. The size of the interstitial spaces also influences the hydraulic conductivity and flow of water which ultimately controls the delivery of carbon and oxygen throughout the ecosystem. Hahn & Fuchs (2009) identified that stygofauna were rare or absent in areas with hydraulic conductivity (K_f) less than 10^{-4}cm/s.

- Stygofauna diversity and abundance typically decreases with depth below ground. Stygofauna are rarely found more than 100 m below ground level and are most abundant less than 20 m below ground (Hancock & Boulton 2008).
- Stygofauna are found across a range of water quality conditions (from fresh to saline), but are most common in fresh and brackish water (i.e. where EC is less than 5,000 µS/cm). 4T (2012) in their review of stygofauna data from Australia reported that stygofauna have been found in hypersaline groundwater (86,900 µS/cm), but are most common at salinities less than 10,000 µS/cm.
- Stygofauna are rarely found in hypoxic groundwater where dissolved oxygen concentrations are less than 0.3 mg/L. 4T (2012) reported that stygofauna have been recorded in groundwater with dissolved oxygen concentrations ranging from 0.2 to 15.3 mg/L.
- Stygofauna are more abundant in areas of surface water-groundwater exchange when compared to deeper areas or those further along the groundwater flow path remote from areas of exchange or recharge with poor hydraulic conductivity. Schmidt *et al.* (2007) noted that hydrological exchange between aquifer and surface water can be more important than other hydrogeological conditions in shaping stygofauna assemblages.

Stygofauna were recorded inhabiting a wide range of lithologies, including unconsolidated sedimentary material (e.g. alluvium, sand); consolidated sedimentary rocks (e.g. sandstone) and fractured rocks (e.g. basalt, granite, volcanics). Whilst sampling data are scarce or absent for many lithologies, the results from Glanville *et al.* (2016) suggest that groundwater systems cannot be eliminated as potential habitat for stygofauna based solely on geology or lithology. Stygofauna were also shown to exist across a diverse physico-chemical range of groundwater systems, and as a result, general assumptions of habitat suitability should not be used to guide sampling activities.

Stygofauna are adapted to a low nutrient (particularly carbon) and oxygen environment. For aquifers to sustain stygofauna there must be a continuous vertical flow of dissolved organic carbon (DOC) from the surface to the aquifer. It is this carbon plus dissolved nutrients that are the basis of the simple food web that sustains bacteria and fungi which stygofauna can feed on (Humphreys 2006). It is largely for this reason that stygofauna diversity and abundance decreases with depth and distance along groundwater flow paths as nutrient supplies decline.

Stygofauna are rarely found more than 100 m below ground level, nor where dissolved oxygen concentrations in the groundwater are less than 0.3 mg O_2/L (Hose *et al.* 2015).

When groundwater in an aquifer that sustains stygofauna is drawndown, the stygofauna become stranded within the pore spaces. Generally, stygofauna can survive in unsaturated sediments for periods of around 48 hours, and survival decreases with decreasing sediment saturation. We do know from limited studies (Tomlinson 2008; Stump & Hose 2013) that some stygofauna can move vertically within the pore spaces and follow the decline in groundwater levels, however, this is only possible if drawdown is slow (perhaps <1.0 m/day), allowing time for the stygofauna to migrate. Rapid drawdown is particularly detrimental for stygofauna and does not allow time for vertical movement to keep pace with the loss of groundwater. Stumpp & Hose (2013) also demonstrated that stygofauna with legs that were able to crawl (e.g. amphipods) were more successful at moving within pore spaces and following the declining groundwater level than some microcrustacea (e.g. copepods) which move within aquifers by swimming.

3.2 Stygofauna Diversity

Hose *et al.* (2015) reports that in 2000 there were over 7,800 known stygofaunal species globally, however, large research efforts in Australia and Europe have shown that this number is an underestimation. Guzik *et al.* (2010) reported some 770 stygofauna taxa were known from Western Australia alone, however, this value was estimated to be only 20% of the true number of stygobiont taxa. True richness for the region may be in excess of 4,000 stygobitic species. Based on these values, and that the diversity of stygofauna in the eastern states is largely unexplored, it is likely Australia is globally significant in terms of stygofauna diversity (Hose *et al.* 2015).

Many of Queensland's stygofauna communities are unstudied or understudied, hampering both global and local comparisons. Queensland is known to host at least 24 described families and 23 described genera of stygofauna across 9 of the 17 major stygofaunal taxonomic groups. Undescribed families have also been recorded across a further three major stygofauna taxonomic groups (Glanville *et al.* 2016). The composition of stygofauna in Queensland is broadly consistent with the world average with the notable exception of high richness of oligochaetes and syncarids and low numbers of molluscs. Despite indications that a significant diversity of stygofauna is likely to exist across Queensland groundwater systems, stygofauna biodiversity largely remains undocumented due to limited sampling effort, limited taxonomic resolution and the tendency for stygofauna to exhibit morphological similarities (Glanville *et al.* 2016).

3.3 Knowledge Gaps Regarding Stygofauna

In 2015, Hose *et al.* published a report commissioned by ACARP entitled "Stygofauna in Australian Groundwater Systems: Extent of Knowledge". This report identified a number of emerging issues where knowledge is lacking with regards to risks to aquifer ecosystems from extractive industry operations such as coal and CSG mining. In particular, Hose *et al.*

(2015) identified a very limited ability to understand and subsequently predict impacts of dewatering/depressurisation of aquifers on stygofauna communities. Additional knowledge-deficient areas were identified as:

- The role of coal seams as stygofauna habitat;
- Water quality tolerance of stygofauna – toxicants and physico-chemical stressors;
- Groundwater foodwebs as a pathway to impact stygofauna;
- Taxonomy and distribution of stygofauna species, and
- Links between hydrological modelling and impacts on stygofauna

4. BMA Sampling Program for Stygofauna

A total of 10 groundwater bores were selected by BMA for stygofauna sampling. All bores developed for the BMA northern extension area were sampled (BMA *pers com*). The location and characteristics of each bore and hydrostratigraphy are presented in Tables 1 and 2 below. Sampling was conducted for this project from 7th to 10th December 2020 and from 10th to 12th May 2021. *Freshwater Ecology* conducted the field assessment with field support provided by ALS.

Table 1: Location of Groundwater Bores Selected for Stygofauna Sampling.

Bore Code	Easting (GDA94:Z55)	Northing (GDA94:Z55)	Formation	Date Drilled	Dates Sampled
MB19BWM02A	690127	7390182	Siltstone (Weathered Rewan)	15/11/19	08/12/20 11/05/21
MB19BWM01P	690037	7390281	Aries Coal Seam	12/11/19	08/12/20 10/05/21
MB19BWM07A	689279	7376877	Alluvium	29/11/19	08/12/20 11/05/21
MB19BWM25P	689259	7376879	Sandstone (Weathered Rewan)	29/11/19	08/12/20 11/05/21
MB19BWM27P	688958	7376559	Aries Coal Seam	18/12/19	08/12/20 11/05/21
MB19BWM03P	688454	7383473	Aries Coal Seam	7/11/19	08/12/20 11/05/21
MB19BWM04R	688315	7383604	Sandstone (Rewan)	11/11/19	08/12/20 11/05/21
MB19BWM05A	688501	7383611	Claystone (Weathered Rewan)	7/11/19	08/12/20 11/05/21
MB19BWM06P	697680	7379450	Aries Coal Seam	5/11/19	08/12/20 11/05/21
MB19BWM08P	691542	7370739	Aries Coal Seam	16/10/19	09/12/20 11/05/21

Table 2: Bore Hole Characteristics (mBGL - metres below ground level; mBTOC - metres below top of casing; EoH – end of hole; SWL – standing water level).

Bore Code	Depth to EoH (mBGL)	SWL (mBTOC) *Dec. 2020*	SWL (mBTOC) *May 2021*	Bore Diameter (mm)	Slotted Depth (m)
MB19BWM02A	17	7.87	7.89	50	12-15
MB19BWM01P	192	12.98	13.34	50	168-171
MB19BWM07A	7	Bore Dry	Bore Dry	50	4-7
MB19BWM25P	20	11.52	11.79	50	17-20
MB19BWM27P	198	4.18	4.44	50	180-189
MB19BWM03P	234	31.37	28.71	50	222-232
MB19BWM04R	80	36.02	35.87	50	71-80
MB19BWM05A	15	Bore Dry	Bore Dry	50	9-15
MB19BWM06P	192	11.57	11.57	50	180-186
MB19BWM08P	198	13.21	13.37	50	184-190

5. Project Methodology

5.1 Sampling Team

Field sampling at BMA Blackwater was conducted by Mr Garry Bennison and Dr Tim Howell from *Freshwater Ecology*. Both staff are professional aquatic ecologists and experienced in stygofauna sample collection and analysis. Garry Bennison has in excess of 40 years' experience as an aquatic ecologist and Tim Howell has in excess of 20 years' experience as an aquatic ecologist. Garry has over 15 years' specific experience working on groundwater ecology projects throughout Australia. *Freshwater Ecology* was supported in the field by Denver O'Grady from ALS Rockhampton.

5.2 Stygofauna Sampling

Sampling was conducted by *Freshwater Ecology* during the pre-wet season in December 2020 and the post-wet season in May 2021. A total of 10 groundwater bores were sampled for stygofauna in accordance with the methods defined in Queensland Environment Protection (Water) Policy 2009 – Monitoring and Sampling Manual: 'Sampling Bores for Stygofauna' (QEPA 2018) and 'Background information on Sampling Bores for Stygofauna' (QEPA 2018) and following established sampling techniques used elsewhere in Australia and overseas (Hancock & Boulton 2008, Dumas & Fontanini 2001, WA EPA Guidance Statements 54 and 54a 2003 & 2007).

A 40mm diameter phreatobiological net was used for stygofauna sampling in all groundwater bores that were 50mm in diameter (net design and construction conformed with WA EPA Guideline [2003 & 2007] specifications). Nets were made of 50 µm nybolt mesh material and weighted at the bottom with a brass fixture and an attached plastic collecting jar. The net was lowered to the bottom of the bore, bounced three to five times to dislodge any resting animals, and slowly retrieved. At the top of each haul, the collecting jar was rinsed into a 50 µm mesh brass sieve and the net lowered again.

Once six hauls were completed (the aim was always to collect between 3 and 6 hauls with all hauls reaching the bottom of the bore), the entire sieve contents were transferred to a labelled sample jar and preserved in methylated spirits as DNA testing of aquatic specimens was not required. A small amount of Rose Bengal, which stains animal tissue pink, was added to each sample to aid in sample processing.

All field equipment was of high quality and fit for purpose, well maintained and operated in accordance with the manufacturer's specifications. It is noteworthy that stygofauna sampling was conducted three weeks following pumping of the groundwater bores by ALS

for routine monthly water quality monitoring for both the December 2020 and May 2021 sampling events.

All field data was recorded on-site using specialised field sampling sheets and photos were taken of each bore sampled, including surrounding land use.

5.3 Laboratory Processing of Field Samples

Field samples were logged into a Laboratory Information Management System to record and track sample processing details. Stygofauna sample containers were drained of methylated spirits and stain and washed gently into channelled Sedgwick-Rafter counting trays to create a thin layer of sediment spread across the bottom of the tray. Samples were then sorted under a stereomicroscope with 10x objective lenses and a zoom capability of between 6.3x and 60x. All aquatic animals present were removed (stygofauna and non-stygofauna) and identified to Order/Family level (or lower taxonomic rank if visually possible) in accordance with standard DES ToR and placed in labelled, polyethylene containers filled with 100% Analytical Reagent Grade ethanol for long-term storage.

5.4 Groundwater Quality Sampling

Water samples were collected from each bore using a bailer lowered by hand to approximately 3 m below the water surface (SWL) prior to stygofauna sampling. Water was measured for temperature (°C), pH (units), electrical conductivity (µS/cm), dissolved oxygen (mg/L) and turbidity (NTU) using a multi-parameter water quality meter to provide a general estimate of standing groundwater quality. The field meter was calibrated in the laboratory prior to its use in the field, with calibrations regularly cross-checked in the field.

Depth to groundwater (SWL) was measured from the top of each bore casing using an electronic dip probe provided by ALS.

Groundwater sampling preceded biological sampling to ensure the groundwater contained within the bore was undisturbed.

6. Results

In-situ groundwater quality monitoring results are presented in Table 3. The groundwater bores ranged in depth from 7 m to 234 m bgl and included a range of standard water quality profiles, although all bores recorded quite high salinities with the exception of MB19BWM25P and MB19BWM08P. High pH values were recorded at bore MB19BWM01P (Dec'20 and May'21) and an unusually high turbidity value was recorded for bore MB19BWM04R in May 2021 when compared to the same bore in December 2020.

Table 3: Groundwater Quality

Bore Code	Temperature (°C)		Dissolved Oxygen (% satn)		Turbidity (NTU)		pH (units)		EC (µS/cm)		Volume Sampled (L)
	Dec'20	May'21	Dec'20	May'21	Dec'20	May'21	Dec'20	May'21	Dec'20	May'21	
MB19BWM02A	26.6	27.98	12.1	22.0	22.0	7.24	6.33	6.29	37,251	36,962	2
MB19BWM01P	26.6	26.17	24.1	52.0	20.4	18.1	11.52	11.70	21,201	20,870	2
MB19BWM07A	-	-	-	-	-	-	-	-	-	-	Bore Dry
MB19BWM25P	27.4	28.7	18.6	22.4	3.1	8.01	7.38	7.17	4,360	5,015	2
MB19BWM27P	27.3	28.27	26.6	21.8	12.0	15.63	7.53	7.22	13,060	13,994	2
MB19BWM03P	26.9	24.96	29.6	24.9	49.4	43.4	8.23	8.05	12,260	13,177	2
MB19BWM04R	27.2	23.31	26.0	22.3	10.6	58.6	7.28	6.96	33,890	34,092	2
MB19BWM05A	-	-	-	-	-	-	-	-	-	-	Bore Dry
MB19BWM06P	-	-	-	-	-	-	-	-	-	-	No Sample*
MB19BWM08P	24.7	28.31	25.4	26.5	14.9	9.93	7.88	7.53	5,790	5,420	2

{No Sample* - Bore MB19BWM06P was damaged and the hand bailer could not reach the groundwater (SWL 11.57m) to collect a water sample. The dip probe and stygofauna net were both able to pass through the constriction.}

The quality of stygofauna samples collected across 10 groundwater bores in December 2020 and May 2021 is summarised in Table 4. The sampling method aimed to collect between four and six replicate hauls off the bottom of each bore in order to be classified as a good sample. Overall, high quality stygofauna samples were collected from 7 of 8 bores that contained water (88%) which indicates both a significant and successful sampling effort.

Table 4: Summary of Stygofauna Sampling Effort and Sample Quality.

Bore Code	No. Replicate Samples		Sample Quality
	Dec 2020	May 2021	
MB19BWM02A	6	5	Good samples with all hauls off the bottom of the bore.
MB19BWM01P	4	3	Generally good samples with all hauls off the bottom of the bore.
MB19BWM07A	-	-	Bore Dry. No sample
MB19BWM25P	6	5	Good samples with all hauls off the bottom of the bore.
MB19BWM27P	3	3	Average samples with stygofauna net clogging with colloidal clays. Not all samples off the bottom of the bore.
MB19BWM03P	4	3	Generally good samples with all hauls off the bottom of the bore.
MB19BWM04R	6	4	Good samples with all hauls off the bottom of the bore.
MB19BWM05A	-	-	Bore Dry. No sample
MB19BWM06P	4	4	Good samples with all hauls off the bottom of the bore.
MB19BWM08P	4	4	Good samples with all hauls off the bottom of the bore.

Results from the analysis of the groundwater samples for the presence of stygofauna are presented in Table 5 below. No stygofauna (stygobites or stygophiles) were recorded from any of the 10 groundwater bores sampled in December 2020 and May 2021. A total of 12 non-stygofauna taxa (stygoxenes) were recovered from four groundwater bores in December 2020 including 11 Isoptera (termites) and one Oribatida (soil mite). Sampling in May 2021 recovered five non-stygofauna taxa (stygoxenes) from three groundwater bores including three Thysanoptera (thrips) and two Collembola (springtails).

Figure 1 shows the presence of Isoptera from groundwater bore MB19BWM03P in December 2020 and Figure 2 shows the presence of Thysanoptera and Collembola from bores MB19BWM25P and MB19BWM04R in May 2021.

Table 5: Analysis of Groundwater Samples for the Presence of Stygofauna. Sampling was conducted in December 2020 and May 2021.

Bore Code	Dates Sampled	Stygofauna Taxa (Dec'20/May'21)	Non-Stygofauna Taxa (Dec 2020)	Non-Stygofauna Taxa (May 2021)
MB19BWM02A	08/12/20 11/05/21	0	4 Isoptera	1 Thysanoptera
MB19BWM01P	08/12/20 10/05/21	0	3 Isoptera 1 Oribatida	0
MB19BWM07A	08/12/20 11/05/21	Bore Dry	Bore Dry	Bore Dry
MB19BWM25P	08/12/20 11/05/21	0	0	2 Thysanoptera
MB19BWM27P	08/12/20 11/05/21	0	0	0
MB19BWM03P	08/12/20 11/05/21	0	3 Isoptera	0
MB19BWM04R	08/12/20 11/05/21	0	0	2 Collembola
MB19BWM05A	08/12/20 11/05/21	Bore Dry	Bore Dry	Bore Dry
MB19BWM06P	08/12/20 11/05/21	0	0	0
MB19BWM08P	09/12/20 11/05/21	0	1 Isoptera	0

Figure 1: Isoptera (termites) recorded from Bore MB19BWM03P in December 2020 (Photo: Chris Pietsch)**.**

Figure 2 2: Thysanoptera (thrips) and Collembola (springtails) recorded from Bores MB19BWM04R and MB19BWM25P in May 2021 (Photo: Chris Pietsch)**.**

7. Conclusion

Two stygofauna sampling events were conducted by Freshwater Ecology at the BMA Blackwater Mine in December 2020 (pre-wet) and May 2021 (post-wet). Ten groundwater bores, selected by BMA, were sampled on each occasion in accordance with the methods defined in Queensland Environment Protection (Water) Policy 2009 – Monitoring and Sampling Manual: 'Sampling Bores for Stygofauna' (QEPA 2018) and 'Background information on Sampling Bores for Stygofauna' (QEPA 2018) and following established (standard) sampling techniques used elsewhere in Australia and overseas (Hancock & Boulton 2008, Dumas & Fontanini 2001, WA EPA Guidance Statements 54 and 54a 2003 & 2007). A significant sampling effort produced a total of 68 high quality samples across both sampling events.

No stygofauna (stygobites or stygophiles) were recovered from any of the 20 samples collected across two sampling events covering pre-wet and post-wet seasons. Two of the 10 bores that were sampled exhibited *in-situ* water quality conducive to the presence of stygofauna, in particular, relatively low salinity (<5,500 μS/cm), pH between 7 and 8 units, low turbidity (<10 NTU) and a dissolved oxygen concentration between 19% and 27% saturation. Six of the 10 sampling sites recorded the presence of non-stygofauna taxa (stygoxenes). The presence of the stygoxene taxa do not add any significant information to this Pilot Survey.

It is important to note that the lack of stygofauna recovered from these two sampling events does not necessarily mean stygofauna do not exist in aquifers associated with the BMA Blackwater Coal Mine. Sampling intensity across different seasons and across a range of aquifers present, with an emphasis on alluvial aquifers, is important.

8. References

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Attachment C Protected Matter Search Tool Reports

EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected. Please see the caveat for interpretation of information provided here.

Report created: 14-Sep-2023

Summary

Matters of National Environment Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Importance (Ramsar	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	None
Listed Threatened Ecological Communities:	6
Listed Threatened Species:	35
Listed Migratory Species:	14

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at https://www.dcceew.gov.au/parks-heritage/heritage

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Lands:	1
Commonwealth Heritage Places:	None
Listed Marine Species:	19
Whales and Other Cetaceans:	None
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	None
Habitat Critical to the Survival of Marine Turtles:	None

Extra Information

This part of the report provides information that may also be relevant to the area you have

State and Territory Reserves:	2
Regional Forest Agreements:	None
Nationally Important Wetlands:	None
EPBC Act Referrals:	13
Key Ecological Features (Marine):	None
Biologically Important Areas:	None
Bioregional Assessments:	None
Geological and Bioregional Assessments:	None

Details

Matters of National Environmental Significance

Listed Threatened Ecological Communities [Resource Information]

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.
Status of Vulnerable, Disallowed and Ineligible are not MNES under the EPBC Act.

Community Name	Threatened Category	Presence Text	Buffer Status
Brigalow (Acacia harpophylla dominant and co-dominant)	Endangered	Community known to occur within area	In buffer area only
Coolibah - Black Box Woodlands of the Darling Riverine Plains and the Brigalow Belt South Bioregions	Endangered	Community may occur within area	In buffer area only
Natural Grasslands of the Queensland Central Highlands and northern Fitzroy Basin	Endangered	Community likely to occur within area	In feature area
Poplar Box Grassy Woodland on Alluvial Plains	Endangered	Community likely to occur within area	In feature area
Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions	Endangered	Community likely to occur within area	In buffer area only
Weeping Myall Woodlands	Endangered	Community likely to occur within area	In feature area

Listed Threatened Species [Resource Information]

Status of Conservation Dependent and Extinct are not MNES under the EPBC Act.
Number is the current name ID.

Scientific Name	Threatened Category	Presence Text	Buffer Status
BIRD			
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area	In feature area
Erythrotriorchis radiatus Red Goshawk [942]	Endangered	Species or species habitat likely to occur within area	In feature area

Scientific Name	Threatened Category	Presence Text	Buffer Status
Falco hypoleucos Grey Falcon [929]	Vulnerable	Species or species habitat likely to occur within area	In feature area
Geophaps scripta scripta Squatter Pigeon (southern) [64440]	Vulnerable	Species or species habitat known to occur within area	In feature area
Grantiella picta Painted Honeyeater [470]	Vulnerable	Species or species habitat known to occur within area	In feature area
Hirundapus caudacutus White-throated Needletail [682]	Vulnerable	Species or species habitat may occur within area	In buffer area only
Neochmia ruficauda ruficauda Star Finch (eastern), Star Finch (southern) [26027]	Endangered	Species or species habitat likely to occur within area	In feature area
Poephila cincta cincta Southern Black-throated Finch [64447]	Endangered	Species or species habitat may occur within area	In feature area
Rostratula australis Australian Painted Snipe [77037]	Endangered	Species or species habitat likely to occur within area	In feature area
Stagonopleura guttata Diamond Firetail [59398]	Vulnerable	Species or species habitat may occur within area	In feature area
Turnix melanogaster Black-breasted Button-quail [923]	Vulnerable	Species or species habitat may occur within area	In buffer area only
MAMMAL			
Chalinolobus dwyeri Large-eared Pied Bat, Large Pied Bat [183]	Vulnerable	Species or species habitat may occur within area	In buffer area only
Dasyurus hallucatus Northern Quoll, Digul [Gogo-Yimidir], Wijingadda [Dambimangari], Wiminji [Martu] [331]	Endangered	Species or species habitat likely to occur within area	In feature area

Scientific Name	Threatened Category	Presence Text	Buffer Status
Macroderma gigas Ghost Bat [174]	Vulnerable	Species or species habitat may occur within area	In feature area
Nyctophilus corbeni Corben's Long-eared Bat, South-eastern Long-eared Bat [83395]	Vulnerable	Species or species habitat may occur within area	In feature area
Petauroides volans Greater Glider (southern and central) [254]	Endangered	Species or species habitat likely to occur within area	In feature area
Petaurus australis australis Yellow-bellied Glider (south-eastern) [87600]	Vulnerable	Species or species habitat likely to occur within area	In buffer area only
Phascolarctos cinereus (combined populations of Qld, NSW and the ACT) Koala (combined populations of Queensland, New South Wales and the Australian Capital Territory) [85104]	Endangered	Species or species habitat likely to occur within area	In feature area
PLANT			
Arthraxon hispidus Hairy-joint Grass [9338]	Vulnerable	Species or species habitat likely to occur within area	In buffer area only
Bertya opponens [13792]	Vulnerable	Species or species habitat known to occur within area	In buffer area only
Cadellia pentastylis Ooline [9828]	Vulnerable	Species or species habitat likely to occur within area	In feature area
Daviesia discolor [3567]	Vulnerable	Species or species habitat known to occur within area	In buffer area only
Dichanthium queenslandicum King Blue-grass [5481]	Endangered	Species or species habitat may occur within area	In feature area
Dichanthium setosum bluegrass [14159]	Vulnerable	Species or species habitat may occur within area	In buffer area only

Scientific Name	Threatened Category	Presence Text	Buffer Status
Eucalyptus raveretiana Black Ironbox [16344]	Vulnerable	Species or species habitat may occur within area	In buffer area only
Homoranthus decumbens a shrub [55186]	Endangered	Species or species habitat may occur within area	In buffer area only
Macrozamia platyrhachis cycad [3412]	Endangered	Species or species habitat likely to occur within area	In buffer area only
Polianthion minutiflorum [82772]	Vulnerable	Species or species habitat likely to occur within area	In buffer area only
Solanum dissectum [75720]	Endangered	Species or species habitat may occur within area	In buffer area only
REPTILE			
Delma torquata Adorned Delma, Collared Delma [1656]	Vulnerable	Species or species habitat likely to occur within area	In feature area
Denisonia maculata Ornamental Snake [1193]	Vulnerable	Species or species habitat known to occur within area	In feature area
Egernia rugosa Yakka Skink [1420]	Vulnerable	Species or species habitat known to occur within area	In feature area
Elseya albagula Southern Snapping Turtle, White-throated Snapping Turtle [81648]	Critically Endangered	Species or species habitat may occur within area	In feature area
Hemiaspis damelii Grey Snake [1179]	Endangered	Species or species habitat may occur within area	In feature area
Rheodytes leukops Fitzroy River Turtle, Fitzroy Tortoise, Fitzroy Turtle, White-eyed River Diver [1761]	Vulnerable	Species or species habitat likely to occur within area	In feature area

Listed Migratory Species [Resource Information]

Scientific Name	Threatened Category	Presence Text	Buffer Status
Migratory Marine Birds			
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area	In feature area
Migratory Terrestrial Species			
Cuculus optatus Oriental Cuckoo, Horsfield's Cuckoo [86651]		Species or species habitat may occur within area	In feature area
Hirundapus caudacutus White-throated Needletail [682]	Vulnerable	Species or species habitat may occur within area	In buffer area only
Monarcha melanopsis Black-faced Monarch [609]		Species or species habitat may occur within area	In buffer area only
Motacilla flava Yellow Wagtail [644]		Species or species habitat may occur within area	In feature area
Myiagra cyanoleuca Satin Flycatcher [612]		Species or species habitat may occur within area	In feature area
Rhipidura rufifrons Rufous Fantail [592]		Species or species habitat may occur within area	In buffer area only
Symposiachrus trivirgatus as Monarcha trivirgatus Spectacled Monarch [83946]		Species or species habitat may occur within area	In buffer area only
Migratory Wetlands Species			
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat may occur within area	In feature area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat likely to occur within area	In feature area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area	In feature area

Scientific Name	Threatened Category	Presence Text	Buffer Status
Calidris melanotos			
Pectoral Sandpiper [858]		Species or species habitat may occur within area	In feature area
Gallinago hardwickii			
Latham's Snipe, Japanese Snipe [863]		Species or species habitat may occur within area	In feature area
Pandion haliaetus			
Osprey [952]		Species or species habitat likely to occur within area	In buffer area only

Other Matters Protected by the EPBC Act

Commonwealth Lands [Resource Information]

The Commonwealth area listed below may indicate the presence of Commonwealth land in this vicinity. Due to the unreliability of the data source, all proposals should be checked as to whether it impacts on a Commonwealth area, before making a definitive decision. Contact the State or Territory government land department for further information.

Commonwealth Land Name	State	Buffer Status
Defence		
Defence - BLACKWATER TRAINING DEPOT [30270]	QLD	In buffer area only

Listed Marine Species [Resource Information]

Scientific Name	Threatened Category	Presence Text	Buffer Status
Bird			
Actitis hypoleucos			
Common Sandpiper [59309]		Species or species habitat may occur within area	In feature area
Anseranas semipalmata			
Magpie Goose [978]		Species or species habitat may occur within area overfly marine area	In feature area
Apus pacificus			
Fork-tailed Swift [678]		Species or species habitat likely to occur within area overfly marine area	In feature area
Bubulcus ibis as Ardea ibis			
Cattle Egret [66521]		Species or species habitat may occur within area overfly marine area	In feature area

Scientific Name	Threatened Category	Presence Text	Buffer Status
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat likely to occur within area	In feature area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area overfly marine area	In feature area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area overfly marine area	In feature area
Chalcites osculans as Chrysococcyx osculans Black-eared Cuckoo [83425]		Species or species habitat likely to occur within area overfly marine area	In feature area
Gallinago hardwickii Latham's Snipe, Japanese Snipe [863]		Species or species habitat may occur within area overfly marine area	In feature area
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat likely to occur within area	In feature area
Hirundapus caudacutus White-throated Needletail [682]	Vulnerable	Species or species habitat may occur within area overfly marine area	In buffer area only
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area overfly marine area	In feature area
Monarcha melanopsis Black-faced Monarch [609]		Species or species habitat may occur within area overfly marine area	In buffer area only
Motacilla flava Yellow Wagtail [644]		Species or species habitat may occur within area overfly marine area	In feature area

Scientific Name	Threatened Category	Presence Text	Buffer Status
Myiagra cyanoleuca			
Satin Flycatcher [612]		Species or species habitat may occur within area overfly marine area	In feature area
Pandion haliaetus			
Osprey [952]		Species or species habitat likely to occur within area	In buffer area only
Rhipidura rufifrons			
Rufous Fantail [592]		Species or species habitat may occur within area overfly marine area	In buffer area only
Rostratula australis as Rostratula benghalensis (sensu lato)			
Australian Painted Snipe [77037]	Endangered	Species or species habitat likely to occur within area overfly marine area	In feature area
Symposiachrus trivirgatus as Monarcha trivirgatus			
Spectacled Monarch [83946]		Species or species habitat may occur within area overfly marine area	In buffer area only

Extra Information

State and Territory Reserves			[Resource Information]
Protected Area Name	Reserve Type	State	Buffer Status
Blackdown Tableland	National Park	QLD	In buffer area only
Blackwater	Conservation Park	QLD	In buffer area only

EPBC Act Referrals				[Resource Information]
Title of referral	Reference	Referral Outcome	Assessment Status	Buffer Status
rail track to link the proposed MIM Rolleston coal mine to existing rail network	2002/637		Post-Approval	In buffer area only
Controlled action				
Blackwater creek diversion and coal mine	2007/3925	Controlled Action	Post-Approval	In buffer area only
Bowen Gas Project	2012/6377	Controlled Action	Post-Approval	In feature area

Title of referral	Reference	Referral Outcome	Assessment Status	Buffer Status
Controlled action				
Construct and operate a coal gasification plant and carbon dioxide capture and storage	2006/3040	Controlled Action	Completed	In buffer area only
Curragh Extension Project, Blackwater, QLD	2015/7508	Controlled Action	Post-Approval	In buffer area only
Norwich Park & Blackwater CSG Fields & supporting infrastructure Bowen Basin	2011/6032	Controlled Action	Completed	In feature area
ZeroGen Integrated Gasification Combined Cycle Power Plant and CO2 Capture, Transport and Storage	2009/5195	Controlled Action	Completed	In feature area
Not controlled action				
Blackwater to Emerald Dual Circuit 132kV Powerline, QLD	2012/6480	Not Controlled Action	Completed	In buffer area only
Development and operation of a new multi-seam underground coal mine with associated on-site infrastr	2011/5811	Not Controlled Action	Completed	In buffer area only
Improving rabbit biocontrol: releasing another strain of RHDV, sthrn two thirds of Australia	2015/7522	Not Controlled Action	Completed	In feature area
Springsure Creek 132kV powerline and switchyards	2012/6385	Not Controlled Action	Completed	In buffer area only
Not controlled action (particular manner)				
Blackwater to Rolleston 132 kV transmission line	2002/880	Not Controlled Action (Particular Manner)	Post-Approval	In buffer area only
Curragh West Project	2011/6187	Not Controlled Action (Particular Manner)	Post-Approval	In buffer area only

Caveat

1 PURPOSE

This report is designed to assist in identifying the location of matters of national environmental significance (MNES) and other matters protected by the Environment Protection and Biodiversity Conservation Act 1999 (Cth) (EPBC Act) which may be relevant in determining obligations and requirements under the EPBC Act.

The report contains the mapped locations of:

- World and National Heritage properties;
- Wetlands of International and National Importance;
- Commonwealth and State/Territory reserves;
- distribution of listed threatened, migratory and marine species;
- listed threatened ecological communities; and
- other information that may be useful as an indicator of potential habitat value.

2 DISCLAIMER

This report is not intended to be exhaustive and should only be relied upon as a general guide as mapped data is not available for all species or ecological communities listed under the EPBC Act (see below). Persons seeking to use the information contained in this report to inform the referral of a proposed action under the EPBC Act should consider the limitations noted below and whether additional information is required to determine the existence and location of MNES and other protected matters.

Where data are available to inform the mapping of protected species, the presence type (e.g. known, likely or may occur) that can be determined from the data is indicated in general terms. It is the responsibility of any person using or relying on the information in this report to ensure that it is suitable for the circumstances of any proposed use. The Commonwealth cannot accept responsibility for the consequences of any use of the report or any part thereof. To the maximum extent allowed under governing law, the Commonwealth will not be liable for any loss or damage that may be occasioned directly or indirectly through the use of, or reliance

3 DATA SOURCES

Threatened ecological communities

For threatened ecological communities where the distribution is well known, maps are generated based on information contained in recovery plans, State vegetation maps and remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Threatened, migratory and marine species

Threatened, migratory and marine species distributions have been discerned through a variety of methods. Where distributions are well known and if time permits, distributions are inferred from either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc.) together with point locations and described habitat; or modelled (MAXENT or BIOCLIM habitat modelling) using

Where little information is available for a species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc.).

In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More detailed distribution mapping methods are used to update these distributions

4 LIMITATIONS

The following species and ecological communities have not been mapped and do not appear in this report:

- threatened species listed as extinct or considered vagrants;
- some recently listed species and ecological communities;
- some listed migratory and listed marine species, which are not listed as threatened species; and
- migratory species that are very widespread, vagrant, or only occur in Australia in small numbers.

The following groups have been mapped, but may not cover the complete distribution of the species:

- listed migratory and/or listed marine seabirds, which are not listed as threatened, have only been mapped for recorded
- seals which have only been mapped for breeding sites near the Australian continent

The breeding sites may be important for the protection of the Commonwealth Marine environment.

Refer to the metadata for the feature group (using the Resource Information link) for the currency of the information.

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

-Office of Environment and Heritage, New South Wales
-Department of Environment and Primary Industries, Victoria
-Department of Primary Industries, Parks, Water and Environment, Tasmania
-Department of Environment, Water and Natural Resources, South Australia
-Department of Land and Resource Management, Northern Territory
-Department of Environmental and Heritage Protection, Queensland
-Department of Parks and Wildlife, Western Australia
-Environment and Planning Directorate, ACT
-Birdlife Australia
-Australian Bird and Bat Banding Scheme
-Australian National Wildlife Collection
-Natural history museums of Australia
-Museum Victoria
-Australian Museum
-South Australian Museum
-Queensland Museum
-Online Zoological Collections of Australian Museums
-Queensland Herbarium
-National Herbarium of NSW
-Royal Botanic Gardens and National Herbarium of Victoria
-Tasmanian Herbarium
-State Herbarium of South Australia
-Northern Territory Herbarium
-Western Australian Herbarium
-Australian National Herbarium, Canberra
-University of New England
-Ocean Biogeographic Information System
-Australian Government, Department of Defence
Forestry Corporation, NSW
-Geoscience Australia
-CSIRO
-Australian Tropical Herbarium, Cairns
-eBird Australia
-Australian Government – Australian Antarctic Data Centre
-Museum and Art Gallery of the Northern Territory
-Australian Government National Environmental Science Program
-Australian Institute of Marine Science
-Reef Life Survey Australia
-American Museum of Natural History
-Queen Victoria Museum and Art Gallery, Inveresk, Tasmania
-Tasmanian Museum and Art Gallery, Hobart, Tasmania
-Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the Contact us page.

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EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected. Please see the caveat for interpretation of information provided here.

Report created: 14-Sep-2023

Summary

Matters of National Environment Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Importance (Ramsar	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	None
Listed Threatened Ecological Communities:	6
Listed Threatened Species:	43
Listed Migratory Species:	14

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at https://www.dcceew.gov.au/parks-heritage/heritage

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Lands:	1
Commonwealth Heritage Places:	None
Listed Marine Species:	19
Whales and Other Cetaceans:	None
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	None
Habitat Critical to the Survival of Marine Turtles:	None

Extra Information

This part of the report provides information that may also be relevant to the area you have

State and Territory Reserves:	7
Regional Forest Agreements:	None
Nationally Important Wetlands:	None
EPBC Act Referrals:	37
Key Ecological Features (Marine):	None
Biologically Important Areas:	None
Bioregional Assessments:	None
Geological and Bioregional Assessments:	None

Details

Matters of National Environmental Significance

Listed Threatened Ecological Communities [Resource Information]

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.
Status of Vulnerable, Disallowed and Ineligible are not MNES under the EPBC Act.

Community Name	Threatened Category	Presence Text	Buffer Status
Brigalow (Acacia harpophylla dominant and co-dominant)	Endangered	Community known to occur within area	In buffer area only
Coolibah - Black Box Woodlands of the Darling Riverine Plains and the Brigalow Belt South Bioregions	Endangered	Community may occur within area	In buffer area only
Natural Grasslands of the Queensland Central Highlands and northern Fitzroy Basin	Endangered	Community likely to occur within area	In feature area
Poplar Box Grassy Woodland on Alluvial Plains	Endangered	Community likely to occur within area	In feature area
Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions	Endangered	Community likely to occur within area	In buffer area only
Weeping Myall Woodlands	Endangered	Community likely to occur within area	In feature area

Listed Threatened Species [Resource Information]

Status of Conservation Dependent and Extinct are not MNES under the EPBC Act.
Number is the current name ID.

Scientific Name	Threatened Category	Presence Text	Buffer Status
BIRD			
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area	In feature area
Erythrotriorchis radiatus Red Goshawk [942]	Endangered	Species or species habitat known to occur within area	In feature area

Scientific Name	Threatened Category	Presence Text	Buffer Status
Falco hypoleucos Grey Falcon [929]	Vulnerable	Species or species habitat likely to occur within area	In feature area
Geophaps scripta scripta Squatter Pigeon (southern) [64440]	Vulnerable	Species or species habitat known to occur within area	In feature area
Grantiella picta Painted Honeyeater [470]	Vulnerable	Species or species habitat known to occur within area	In feature area
Hirundapus caudacutus White-throated Needletail [682]	Vulnerable	Species or species habitat may occur within area	In buffer area only
Neochmia ruficauda ruficauda Star Finch (eastern), Star Finch (southern) [26027]	Endangered	Species or species habitat likely to occur within area	In feature area
Poephila cincta cincta Southern Black-throated Finch [64447]	Endangered	Species or species habitat may occur within area	In feature area
Rostratula australis Australian Painted Snipe [77037]	Endangered	Species or species habitat likely to occur within area	In feature area
Stagonopleura guttata Diamond Firetail [59398]	Vulnerable	Species or species habitat may occur within area	In feature area
Turnix melanogaster Black-breasted Button-quail [923]	Vulnerable	Species or species habitat likely to occur within area	In buffer area only
MAMMAL			
Chalinolobus dwyeri Large-eared Pied Bat, Large Pied Bat [183]	Vulnerable	Species or species habitat may occur within area	In buffer area only
Dasyurus hallucatus Northern Quoll, Digul [Gogo-Yimidir], Wijingadda [Dambimangari], Wiminji [Martu] [331]	Endangered	Species or species habitat likely to occur within area	In feature area

Scientific Name	Threatened Category	Presence Text	Buffer Status
Macroderma gigas Ghost Bat [174]	Vulnerable	Species or species habitat may occur within area	In feature area
Nyctophilus corbeni Corben's Long-eared Bat, South-eastern Long-eared Bat [83395]	Vulnerable	Species or species habitat may occur within area	In feature area
Onychogalea fraenata Bridled Nail-tail Wallaby, Bridled Nailtail Wallaby [239]	Endangered	Species or species habitat known to occur within area	In buffer area only
Petauroides volans Greater Glider (southern and central) [254]	Endangered	Species or species habitat known to occur within area	In feature area
Petaurus australis australis Yellow-bellied Glider (south-eastern) [87600]	Vulnerable	Species or species habitat known to occur within area	In buffer area only
Phascolarctos cinereus (combined populations of Qld, NSW and the ACT) Koala (combined populations of Queensland, New South Wales and the Australian Capital Territory) [85104]	Endangered	Species or species habitat known to occur within area	In feature area
Pteropus poliocephalus Grey-headed Flying-fox [186]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area	In buffer area only
PLANT			
Aristida annua [17906]	Vulnerable	Species or species habitat known to occur within area	In buffer area only
Arthraxon hispidus Hairy-joint Grass [9338]	Vulnerable	Species or species habitat likely to occur within area	In buffer area only
Bertya opponens [13792]	Vulnerable	Species or species habitat known to occur within area	In buffer area only
Cadellia pentastylis Ooline [9828]	Vulnerable	Species or species habitat likely to occur within area	In feature area

Scientific Name	Threatened Category	Presence Text	Buffer Status
Daviesia discolor [3567]	Vulnerable	Species or species habitat known to occur within area	In buffer area only
Dichanthium queenslandicum King Blue-grass [5481]	Endangered	Species or species habitat known to occur within area	In feature area
Dichanthium setosum bluegrass [14159]	Vulnerable	Species or species habitat likely to occur within area	In buffer area only
Eucalyptus raveretiana Black Ironbox [16344]	Vulnerable	Species or species habitat known to occur within area	In buffer area only
Homoranthus decumbens a shrub [55186]	Endangered	Species or species habitat known to occur within area	In buffer area only
Leichhardtia brevifolia listed as Marsdenia brevifolia [91893]	Vulnerable	Species or species habitat may occur within area	In buffer area only
Logania diffusa [24159]	Vulnerable	Species or species habitat likely to occur within area	In buffer area only
Macrozamia platyrhachis cycad [3412]	Endangered	Species or species habitat known to occur within area	In buffer area only
Phaius australis Lesser Swamp-orchid [5872]	Endangered	Species or species habitat known to occur within area	In buffer area only
Polianthion minutiflorum [82772]	Vulnerable	Species or species habitat likely to occur within area	In buffer area only
Solanum dissectum [75720]	Endangered	Species or species habitat known to occur within area	In buffer area only
REPTILE			

Scientific Name	Threatened Category	Presence Text	Buffer Status
Delma torquata Adorned Delma, Collared Delma [1656]	Vulnerable	Species or species habitat known to occur within area	In feature area
Denisonia maculata Ornamental Snake [1193]	Vulnerable	Species or species habitat known to occur within area	In feature area
Egernia rugosa Yakka Skink [1420]	Vulnerable	Species or species habitat known to occur within area	In feature area
Elseya albagula Southern Snapping Turtle, White-throated Snapping Turtle [81648]	Critically Endangered	Species or species habitat known to occur within area	In feature area
Furina dunmalli Dunmall's Snake [59254]	Vulnerable	Species or species habitat may occur within area	In buffer area only
Hemiaspis damelii Grey Snake [1179]	Endangered	Species or species habitat known to occur within area	In feature area
Lerista allanae Allan's Lerista, Retro Slider [1378]	Endangered	Species or species habitat may occur within area	In buffer area only
Rheodytes leukops Fitzroy River Turtle, Fitzroy Tortoise, Fitzroy Turtle, White-eyed River Diver [1761]	Vulnerable	Species or species habitat known to occur within area	In feature area

Listed Migratory Species

[Resource Information]

Scientific Name	Threatened Category	Presence Text	Buffer Status
Migratory Marine Birds			
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area	In feature area
Migratory Terrestrial Species			
Cuculus optatus Oriental Cuckoo, Horsfield's Cuckoo [86651]		Species or species habitat may occur within area	In feature area

Scientific Name	Threatened Category	Presence Text	Buffer Status
Hirundapus caudacutus White-throated Needletail [682]	Vulnerable	Species or species habitat may occur within area	In buffer area only
Monarcha melanopsis Black-faced Monarch [609]		Species or species habitat known to occur within area	In buffer area only
Motacilla flava Yellow Wagtail [644]		Species or species habitat may occur within area	In feature area
Myiagra cyanoleuca Satin Flycatcher [612]		Species or species habitat may occur within area	In feature area
Rhipidura rufifrons Rufous Fantail [592]		Species or species habitat may occur within area	In buffer area only
Symposiachrus trivirgatus as Monarcha trivirgatus Spectacled Monarch [83946]		Species or species habitat may occur within area	In buffer area only
Migratory Wetlands Species			
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat may occur within area	In feature area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat known to occur within area	In feature area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area	In feature area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area	In feature area
Gallinago hardwickii Latham's Snipe, Japanese Snipe [863]		Species or species habitat known to occur within area	In feature area

Scientific Name	Threatened Category	Presence Text	Buffer Status
Pandion haliaetus			
Osprey [952]		Species or species habitat likely to occur within area	In buffer area only

Other Matters Protected by the EPBC Act

Commonwealth Lands [Resource Information]

The Commonwealth area listed below may indicate the presence of Commonwealth land in this vicinity. Due to the unreliability of the data source, all proposals should be checked as to whether it impacts on a Commonwealth area, before making a definitive decision. Contact the State or Territory government land department for further information.

Commonwealth Land Name	State	Buffer Status
Defence		
Defence - BLACKWATER TRAINING DEPOT [30270]	QLD	In buffer area only

Listed Marine Species [Resource Information]

Scientific Name	Threatened Category	Presence Text	Buffer Status
Bird			
Actitis hypoleucos			
Common Sandpiper [59309]		Species or species habitat may occur within area	In feature area
Anseranas semipalmata			
Magpie Goose [978]		Species or species habitat may occur within area overfly marine area	In feature area
Apus pacificus			
Fork-tailed Swift [678]		Species or species habitat likely to occur within area overfly marine area	In feature area
Bubulcus ibis as Ardea ibis			
Cattle Egret [66521]		Species or species habitat may occur within area overfly marine area	In feature area
Calidris acuminata			
Sharp-tailed Sandpiper [874]		Species or species habitat known to occur within area	In feature area

Scientific Name	Threatened Category	Presence Text	Buffer Status
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area overfly marine area	In feature area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area overfly marine area	In feature area
Chalcites osculans as Chrysococcyx osculans Black-eared Cuckoo [83425]		Species or species habitat likely to occur within area overfly marine area	In feature area
Gallinago hardwickii Latham's Snipe, Japanese Snipe [863]		Species or species habitat known to occur within area overfly marine area	In feature area
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat likely to occur within area	In feature area
Hirundapus caudacutus White-throated Needletail [682]	Vulnerable	Species or species habitat may occur within area overfly marine area	In buffer area only
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area overfly marine area	In feature area
Monarcha melanopsis Black-faced Monarch [609]		Species or species habitat known to occur within area overfly marine area	In buffer area only
Motacilla flava Yellow Wagtail [644]		Species or species habitat may occur within area overfly marine area	In feature area

Scientific Name	Threatened Category	Presence Text	Buffer Status
Myiagra cyanoleuca			
Satin Flycatcher [612]		Species or species habitat may occur within area overfly marine area	In feature area
Pandion haliaetus			
Osprey [952]		Species or species habitat likely to occur within area	In buffer area only
Rhipidura rufifrons			
Rufous Fantail [592]		Species or species habitat may occur within area overfly marine area	In buffer area only
Rostratula australis as Rostratula benghalensis (sensu lato)			
Australian Painted Snipe [77037]	Endangered	Species or species habitat likely to occur within area overfly marine area	In feature area
Symposiachrus trivirgatus as Monarcha trivirgatus			
Spectacled Monarch [83946]		Species or species habitat may occur within area overfly marine area	In buffer area only

Extra Information

State and Territory Reserves			[Resource Information]
Protected Area Name	Reserve Type	State	Buffer Status
Blackdown Tableland	National Park	QLD	In buffer area only
Blackwater	Conservation Park	QLD	In buffer area only
Ghungalu	Conservation Park	QLD	In buffer area only
Humboldt	National Park	QLD	In buffer area only
Kenmare	Nature Refuge	QLD	In buffer area only
Taunton NP	National Park (Scientific)	QLD	In buffer area only
Wallaby Lane	Nature Refuge	QLD	In buffer area only

EPBC Act Referrals				[Resource Information]
Title of referral	Reference	Referral Outcome	Assessment Status	Buffer Status

Title of referral	Reference	Referral Outcome	Assessment Status	Buffer Status
Blackwater Mine South Coking Coal Project	2022/09279		Assessment	In buffer area only
Development and operation of the Star Coal Project Bulk Sample Project	2023/09502		Completed	In buffer area only
Ensham Life of Mine Extension	2020/8669		Post-Approval	In buffer area only
rail track to link the proposed MIM Rolleston coal mine to existing rail network	2002/637		Post-Approval	In buffer area only
Controlled action				
Blackwater creek diversion and coal mine	2007/3925	Controlled Action	Post-Approval	In buffer area only
Blackwater to Gladstone Gas Pipeline Project	2011/6034	Controlled Action	Completed	In buffer area only
Bluff open cut coal mine project, central Queensland	2013/7064	Controlled Action	Post-Approval	In buffer area only
Bowen Gas Project	2012/6377	Controlled Action	Post-Approval	In feature area
Coal Seam Gas Field Development for Natural Gas Liquefaction Park, Curtis Island	2008/4059	Controlled Action	Completed	In buffer area only
Comet Ridge Coal Mine, Comet, QLD	2015/7507	Controlled Action	Further Information Request	In buffer area only
Construct and operate a coal gasification plant and carbon dioxide capture and storage	2006/3040	Controlled Action	Completed	In buffer area only
Curragh Extension Project, Blackwater, QLD	2015/7508	Controlled Action	Post-Approval	In buffer area only
Curragh North Coal Mine	2003/1096	Controlled Action	Post-Approval	In buffer area only
Expansion of Ensham Mine	2004/1822	Controlled Action	Post-Approval	In buffer area only
Fairhill Coal Project	2019/8549	Controlled Action	Post-Approval	In buffer area only
Future Gas Supply Area Project	2012/6357	Controlled Action	Completed	In buffer area only
Jellinbah Coal Mine-Central North Extension, QLD	2018/8139	Controlled Action	Post-Approval	In buffer area only

Title of referral	Reference	Referral Outcome	Assessment Status	Buffer Status
Controlled action				
Norwich Park & Blackwater CSG Fields & supporting infrastructure Bowen Basin	2011/6032	Controlled Action	Completed	In feature area
Norwich Park to Blackwater Gas Pipeline	2011/6031	Controlled Action	Completed	In buffer area only
Santos GLNG Gas Field Development Project, QLD	2012/6615	Controlled Action	Post-Approval	In buffer area only
Springsure Creek Coal Project	2010/5782	Controlled Action	Post-Approval	In buffer area only
Walton Coal Project, Bowen Basin, Qld	2017/8077	Controlled Action	Assessment Approach	In buffer area only
Washpool Coal Mine Project	2009/5240	Controlled Action	Completed	In buffer area only
ZeroGen Integrated Gasification Combined Cycle Power Plant and CO2 Capture, Transport and Storage	2009/5195	Controlled Action	Completed	In feature area
Not controlled action				
Blackwater System Rail Expansion	2011/6209	Not Controlled Action	Completed	In buffer area only
Blackwater to Emerald Dual Circuit 132kV Powerline, QLD	2012/6480	Not Controlled Action	Completed	In buffer area only
Curragh North Pit U Expansion Project	2010/5458	Not Controlled Action	Completed	In buffer area only
Development and operation of a new multi-seam underground coal mine with associated on-site infrastr	2011/5811	Not Controlled Action	Completed	In buffer area only
Improving rabbit biocontrol: releasing another strain of RHDV, sthrn two thirds of Australia	2015/7522	Not Controlled Action	Completed	In feature area
Mackenzie North Project, QLD	2011/5873	Not Controlled Action	Completed	In buffer area only
Mahalo Development Area CSG Project	2019/8534	Not Controlled Action	Completed	In buffer area only
Springsure Creek 132kV powerline and switchyards	2012/6385	Not Controlled Action	Completed	In buffer area only
Wilton Coking Coal Project, Bowen Basin, Qld	2019/8431	Not Controlled Action	Completed	In buffer area only
Not controlled action (particular manner)				

Title of referral	Reference	Referral Outcome	Assessment Status	Buffer Status
Not controlled action (particular manner)				
Blackwater to Rolleston 132 kV transmission line	2002/880	Not Controlled Action (Particular Manner)	Post-Approval	In buffer area only
Curragh West Project	2011/6187	Not Controlled Action (Particular Manner)	Post-Approval	In buffer area only
Dingo West Coal Project	2010/5775	Not Controlled Action (Particular Manner)	Post-Approval	In buffer area only
Referral decision				
Proposal for open cut coal mining operation, central QLD	2013/6946	Referral Decision	Completed	In buffer area only

Caveat

1 PURPOSE

This report is designed to assist in identifying the location of matters of national environmental significance (MNES) and other matters protected by the Environment Protection and Biodiversity Conservation Act 1999 (Cth) (EPBC Act) which may be relevant in determining obligations and requirements under the EPBC Act.

The report contains the mapped locations of:

- World and National Heritage properties;
- Wetlands of International and National Importance;
- Commonwealth and State/Territory reserves;
- distribution of listed threatened, migratory and marine species;
- listed threatened ecological communities; and
- other information that may be useful as an indicator of potential habitat value.

2 DISCLAIMER

This report is not intended to be exhaustive and should only be relied upon as a general guide as mapped data is not available for all species or ecological communities listed under the EPBC Act (see below). Persons seeking to use the information contained in this report to inform the referral of a proposed action under the EPBC Act should consider the limitations noted below and whether additional information is required to determine the existence and location of MNES and other protected matters.

Where data are available to inform the mapping of protected species, the presence type (e.g. known, likely or may occur) that can be determined from the data is indicated in general terms. It is the responsibility of any person using or relying on the information in this report to ensure that it is suitable for the circumstances of any proposed use. The Commonwealth cannot accept responsibility for the consequences of any use of the report or any part thereof. To the maximum extent allowed under governing law, the Commonwealth will not be liable for any loss or damage that may be occasioned directly or indirectly through the use of, or reliance

3 DATA SOURCES

Threatened ecological communities

For threatened ecological communities where the distribution is well known, maps are generated based on information contained in recovery plans, State vegetation maps and remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Threatened, migratory and marine species

Threatened, migratory and marine species distributions have been discerned through a variety of methods. Where distributions are well known and if time permits, distributions are inferred from either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc.) together with point locations and described habitat; or modelled (MAXENT or BIOCLIM habitat modelling) using

Where little information is available for a species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc.).

In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More detailed distribution mapping methods are used to update these distributions

4 LIMITATIONS

The following species and ecological communities have not been mapped and do not appear in this report:

- threatened species listed as extinct or considered vagrants;
- some recently listed species and ecological communities;
- some listed migratory and listed marine species, which are not listed as threatened species; and
- migratory species that are very widespread, vagrant, or only occur in Australia in small numbers.

The following groups have been mapped, but may not cover the complete distribution of the species:

- listed migratory and/or listed marine seabirds, which are not listed as threatened, have only been mapped for recorded
- seals which have only been mapped for breeding sites near the Australian continent

The breeding sites may be important for the protection of the Commonwealth Marine environment.

Refer to the metadata for the feature group (using the Resource Information link) for the currency of the information.

Acknowledgements

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-Office of Environment and Heritage, New South Wales
-Department of Environment and Primary Industries, Victoria
-Department of Primary Industries, Parks, Water and Environment, Tasmania
-Department of Environment, Water and Natural Resources, South Australia
-Department of Land and Resource Management, Northern Territory
-Department of Environmental and Heritage Protection, Queensland
-Department of Parks and Wildlife, Western Australia
-Environment and Planning Directorate, ACT
-Birdlife Australia
-Australian Bird and Bat Banding Scheme
-Australian National Wildlife Collection
-Natural history museums of Australia
-Museum Victoria
-Australian Museum
-South Australian Museum
-Queensland Museum
-Online Zoological Collections of Australian Museums
-Queensland Herbarium
-National Herbarium of NSW
-Royal Botanic Gardens and National Herbarium of Victoria
-Tasmanian Herbarium
-State Herbarium of South Australia
-Northern Territory Herbarium
-Western Australian Herbarium
-Australian National Herbarium, Canberra
-University of New England
-Ocean Biogeographic Information System
-Australian Government, Department of Defence
Forestry Corporation, NSW
-Geoscience Australia
-CSIRO
-Australian Tropical Herbarium, Cairns
-eBird Australia
-Australian Government – Australian Antarctic Data Centre
-Museum and Art Gallery of the Northern Territory
-Australian Government National Environmental Science Program
-Australian Institute of Marine Science
-Reef Life Survey Australia
-American Museum of Natural History
-Queen Victoria Museum and Art Gallery, Inveresk, Tasmania
-Tasmanian Museum and Art Gallery, Hobart, Tasmania
-Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the Contact us page.

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