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Middlemount Coal Mine Southern Extension Project Aquatic Ecology Assessment

September 2020

Middlemount Coal Mine Southern Extension Project – Aquatic Ecology Assessment

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Middlemount Coal Mine Southern Extension Project – Aquatic Ecology Assessment
2 September 2020

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EXECUTIVE SUMMARY

DPM Enviros ciences Pty Ltd was engaged by Middlemount Coal Pty Ltd (MCPL) to undertake aquatic ecological surveys and to prepare an impact assessment for the proposed Middlemount Coal Mine Southern Extension Project (herein referred to as the Project).

The Project includes:

- extension of the open cut pit to the south within Mining Lease (ML) 70379;
- continued extraction of run-of-mine coal up to approximately 5.7 million tonnes per annum (Mtpa) using conventional open cut mining equipment;
- placement of waste rock in existing emplacements, expanded emplacements (West Dump and East Dump) and within the mined-out void;
- minor extensions to waste rock emplacements footprint;
- progressive development of sediment dams, pipelines and other water management equipment and structures;
- re-positioning of the approved southern flood levee and water management infrastructure;
- realignment of the approved (but not yet constructed) eastern diversion of Roper Creek (Roper Creek Diversion 2) inside the MLs;
- progressive development of new haul roads and internal roads;
- continued development of soil stockpiles, laydown areas and borrow areas;
- continued use of existing and approved supporting mine infrastructure;
- extension of the approved mine life by approximately seven years (to 2044); and
- a change to the final landform for the end of the mine life.

In a regional context, the Project is located within the headwaters of the Mackenzie River drainage sub-basin of the greater Fitzroy Basin. Roper Creek transects the Study area, as does Thirteen Mile Gully and an unnamed tributary, both of which flow into Roper Creek. Roper Creek flows into Oaky Creek approximately 37 kilometres (km) downstream of the Study area, which flows into the Mackenzie River approximately 20 km further downstream.

In a local context, the Project lies within the Bowen Basin mining area. Land use within this area typically comprises agriculture and coal mining activities, which have led to large-scale vegetation clearing and habitat fragmentation. The Study area primarily comprises cleared land for agriculture or regrowth vegetation, with small tracts of remnant vegetation throughout.

The scope of this assessment was to describe the aquatic values of the Study area, identify any conservation significant species under the Queensland *Nature Conservation Act 1992* (NC Act), *Fisheries Management Act 1994* and Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), identify the presence of surface expression or subterranean groundwater-dependent ecosystems (GDEs), identify and describe any aquatic Matters of State Environmental Significance (MSES) or Matters of National Environmental Significance (MNES), and to propose impact avoidance and mitigation measures to protect natural values.

The findings discussed in this aquatic ecology assessment are based on a desktop assessment of readily available information on the aquatic characteristics of the Study area (including annual monitoring data from the existing mine), supplemented by a dry season survey in October 2019 and a wet season survey in February 2020.

Aquatic habitat assessments were undertaken in accordance with the Australian River Assessment System (AusRivAS) protocols for Queensland streams. In addition, the Queensland *Guideline for the Environmental Assessment of Subterranean Aquatic Fauna* (Queensland Department of Science, Information Technology and Innovation [DSITI] 2015) and the *Information Guidelines Explanatory Note: Assessing groundwater-dependent ecosystems* (Doody et al. 2019) were applied and a desktop review undertaken to assist in determining the likelihood and significance of surface expression and subterranean GDEs potentially occurring within the Study area. The assessment of subterranean GDEs was supplemented by sampling of 11 representative bores in October 2019 and 10 representative bores in February 2020.

The waterways of the Study area are ephemeral and expected to experience flow only after sustained or intense rainfall and runoff in the catchment. The streambed of Roper Creek is comprised of unconsolidated (loosely arranged and unpacked) sands and silts forming a relatively flat stream bed void of pool or riffle sequences. The transient flow, lack of pools and lack of dry season refuge limits the ability of Roper Creek to provide sustained habitat for native fish and turtles. Thirteen Mile Gully has a smaller catchment, although a more consolidated stream bed of silts and clays, providing a more natural channel profile. Roper Creek and Thirteen Mile Gully may provide temporary foraging habitat for common (Least Concern) native fish and turtle species, and very limited breeding habitat for native fishes adapted to the transient flow conditions.

Waterways providing for fish passage are an MSES only if the construction, installation or modification of waterway barrier works will limit the passage of fish along the waterway. As part of the Project, Roper Creek Diversion 2 (an existing approved diversion) would need to be realigned to allow for the southern extension of the open cut within ML 70379. A diversion is proposed to maintain its ecological function, including for fish habitat and passage and therefore the Project is unlikely to result in a significant impact this MSES. Other potentially relevant MSES are addressed in the terrestrial ecology assessment.

There are no wetlands of International Importance, National Importance or High Ecological Significance within the Study area. No conservation significant aquatic flora or fauna species listed under the NC Act and / or EPBC Act were recorded within the Study area, nor are they expected to occur considering their required habitats are not present. In addition, no MNES species or habitat relevant to aquatic ecology were identified.

Field surveys in October 2019 and February 2020 found no evidence of river-base flow systems or groundwater-fed wetlands in the Study area. No potential surface GDEs are mapped in the Queensland GDE Mapping (DES 2019c) for the Study area, nor are they likely to occur. Quaternary alluvium is distributed within the Middlemount Coal Mine from Roper Creek in the south to Thirteen Mile Gully in the north, and is comprised of clay, silt and sand (AGE 2018). Where it occurs, the alluvium is thin, usually less than 5 metres (m) (Parsons Brinkerhoff 2010, cited in AGE 2020). Groundwater levels at the site are typically below the base of the alluvium, indicating that the alluvium is typically unsaturated (AGE 2018).

No stygofauna were detected in a pilot survey conducted within and surrounding the Study area in October 2019 and February 2020. It is unlikely that subterranean GDEs occur within the Study area. The Study area is already subject to groundwater impacts and its aquifers are unlikely to represent particularly natural or unique habitat for stygofauna that doesn't otherwise occur in the broader area. Accordingly, in the unlikely event that subterranean GDEs do occur in the Study area or surrounds, they would be attributed a low ecological value. Further, any impacts would be insignificant when placed in the context of the wider extent of similar habitat.

Indirect impacts that have been considered in this assessment include potential impacts associated with changes in water quality, hydrological changes, impacts to groundwater dependant ecosystems and potential cumulative impacts. It is concluded that the Project is unlikely to have a significant impact on aquatic ecology as a result of these potential indirect impacts.

In conclusion, the Project is unlikely to result in a significant impact on any MNES or MSES, including conservation significant aquatic species listed under the NC Act and EPBC Act, aquatic ecological communities or their habitats.

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Acronyms

Acronym	Description
ACA	Aquatic Conservation Assessment (associated with AquaBAMM)
ACARP	Australian Coal Association Research Program
ALA	Atlas of Living Australia
AquaBAMM	Aquatic Biodiversity Assessment Mapping Methodology
AusRivAS	Australian River Assessment System
BoM	Bureau of Meteorology
BoT	Back on Track
CE	Critically Endangered (threatened fauna species conservation status)
CHAH	Council of Heads of Australasian Herbaria
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DAF	Queensland Department of Agriculture and Fisheries
DAFF	Queensland Department of Agriculture, Fisheries and Forestry
DEE	Commonwealth Department of the Environment and Energy
DEHP	Queensland Department of Environment and Heritage Protection
DERM	Queensland Department of Environment and Resource Management
DES	Queensland Department of Environment and Science
DNRM	Queensland Department of Natural Resources and Mines
DNRME	Queensland Department of Natural Resources, Mines and Energy
DO	Dissolved Oxygen
DPI	New South Wales Department of Primary Industries
DSEWPC	Department of Sustainability, Environment, Water, Populations and Communities
DSITI	Queensland Department of Science, Information Technology and Innovation
E	Endangered (threatened species conservation status)
EA	Environmental Authority
EC	Electrical Conductivity
EO Act	Queensland *Environmental Offsets Act* 2014
EO Policy	Queensland *Environmental Offsets Policy*
EO Regulation	Queensland Environmental Offsets Regulation 2014
EPP 2019	Environmental Protection (Wetland and Water Biodiversity) Policy 2019
EPBC Act	Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*
EVNT	Endangered, Vulnerable or Near Threatened (threatened fauna species)
GBR	Great Barrier Reef
GDA	Geocentric Datum of Australia
GDE	Groundwater Dependent Ecosystem
GES	General Ecological Significance
HES	High Ecological Significance
HEV	High Environmental Value
IECAA	International Erosion Control Association Australasia
IESC	Independent Expert Scientific Committee
LC	Least Concern species conservation status under the NC Act
mbgl	Metres Below Ground Level
MCPL	Middlemount Coal Pty Ltd
ML	Mining Lease
MNES	Matters of National Environmental Significance
MSES	Matters of State Environmental Significance
Mtpa	Million tonnes per annum
MQWEV	The Map of Queensland Wetland Environmental Values

NC Act	Queensland *Nature Conservation Act 1992*
NRM	Natural Resource Management
NSW	New South Wales
NT	Near Threatened (species conservation status)
PET	Plecoptera, Ephemeroptera and Trichoptera macroinvertebrate richness
QA / QC	Quality assurance / quality control
RPD	Relative Percent Difference
RE	Regional Ecosystem
REMP	Receiving Environment Monitoring Program
SIGNAL2	Stream Invertebrate Grade Number – Average Level Version 2
SLC	Special Least Concern
TEC	Threatened Ecological Community
SPP	State Planning Policy 2017
V	Vulnerable (threatened species status)
WoNS	Weeds of National Significance
WPA	Wetland Protection Area
WQO	Water Quality Objective

Definitions

Term	Description
Aquatic fauna	An aquatic animal is either a vertebrate or invertebrate that lives in water for most or all of its life. It does not include amphibians or waterbirds (which are considered terrestrial fauna).
Aquatic flora	Plants that have adapted to living in aquatic environments (saltwater or freshwater). They are also referred to as hydrophytes or macrophytes. These plants require special adaptations for living submerged in water, or at the water's surface.
Biosecurity matter	A living thing, other than a human or part of a human; or a pathogenic agent that can cause disease in a living thing, other than a human, or a pathogenic agent that can cause disease in a human, by the transmission of a pathogenic agent from an animal to a human; or a disease; or a contaminant.
Groundwater Dependent Ecosystem	Groundwater-dependent Ecosystems (or GDEs) are ecosystems that rely upon groundwater for their continued existence. They may be 100% dependent on groundwater, such as aquifer GDEs, or may access groundwater intermittently to supplement their water requirements, such as riparian tree species in arid and semi-arid areas.
Hyporheic zone	The region of sediment and porous space beneath and alongside a stream bed, where there is mixing of shallow groundwater and surface water. The flow dynamics and behaviour in this zone (termed hyporheic flow or underflow) is recognized to be important for surface water / groundwater interactions, as well as fish spawning, among other processes.
Restricted matter	Listed in Schedule 2 of the Queensland *Biosecurity Act 2014*, and refers to biosecurity matter 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.
Stygofauna	Stygofauna are aquatic fauna that live part or all of their lives in groundwater systems such as aquifers or underground caves. Stygofauna are found in aquifers and caves, inhabiting the water filled pore spaces, voids, cracks and fissures.
Waterway	Waterways include riverine systems, watercourses, waterways or drainage lines identified in the Queensland Wetlands Map, *Fisheries Act 1994*, Queensland Waterways for Waterway Barrier Works, or DNRM Watercourse identification map (*Water Act 2000*).
Wetland	Wetlands include marine, estuarine, riverine, lacustrine and palustrine waterbodies and wetland REs in Qld identified in the Queensland Wetlands Map, Wetlands of International Importance (EPBC Act), Wetlands of National Importance (EPBC Act) and GES, HES and WPA wetlands identified in the Queensland Environmental Values mapping.

1 INTRODUCTION

1.1 Background

Middlemount Coal Pty Ltd (MCPL) owns and operates the Middlemount Coal Mine, an open cut coal mine located approximately 90 kilometres (km) north-east of Emerald and approximately 3 km south-west of the Middlemount Township within the Fitzroy Natural Resource Management (NRM) region, Queensland (Figure 1).

The Middlemount Coal Mine currently operates under Environmental Authority (EA) EMPL00716013, which permits the relevant mining operations to take place within the mining leases (MLs) ML 70379, ML 70417 and ML 700014. MCPL propose to seek approval for changes to the approved Middlemount Coal Mine, herein referred to as the Southern Extension Project (the Project).

1.2 Project Description

The Project involves extending open cut mining of the Middlemount Coal Mine to the south of the existing operations. The main activities associated with the development of the Project would include:

- extension of the open cut pit to the south within ML 70379;
- continued extraction of run-of-mine coal up to approximately 5.7 million tonnes per annum (Mtpa) using conventional open cut mining equipment;
- placement of waste rock in existing emplacements, expanded emplacements (West Dump and East Dump) and within the mined-out void;
- minor extensions to waste rock emplacements footprint;
- progressive development of sediment dams, pipelines and other water management equipment and structures;
- re-positioning of the approved southern flood levee and water management infrastructure;
- realignment and extension of the approved (but not yet constructed) eastern diversion of Roper Creek (Roper Creek Diversion 2) inside the MLs;
- progressive development of new haul roads and internal roads;
- continued development of soil stockpiles, laydown areas and borrow areas;
- continued use of existing and approved supporting mine infrastructure;
- extension of the approved mine life by approximately seven years (to 2044); and
- a change to the final landform for the end of the mine life.

The approximate extent of proposed additional disturbance is shown on Figure 2.

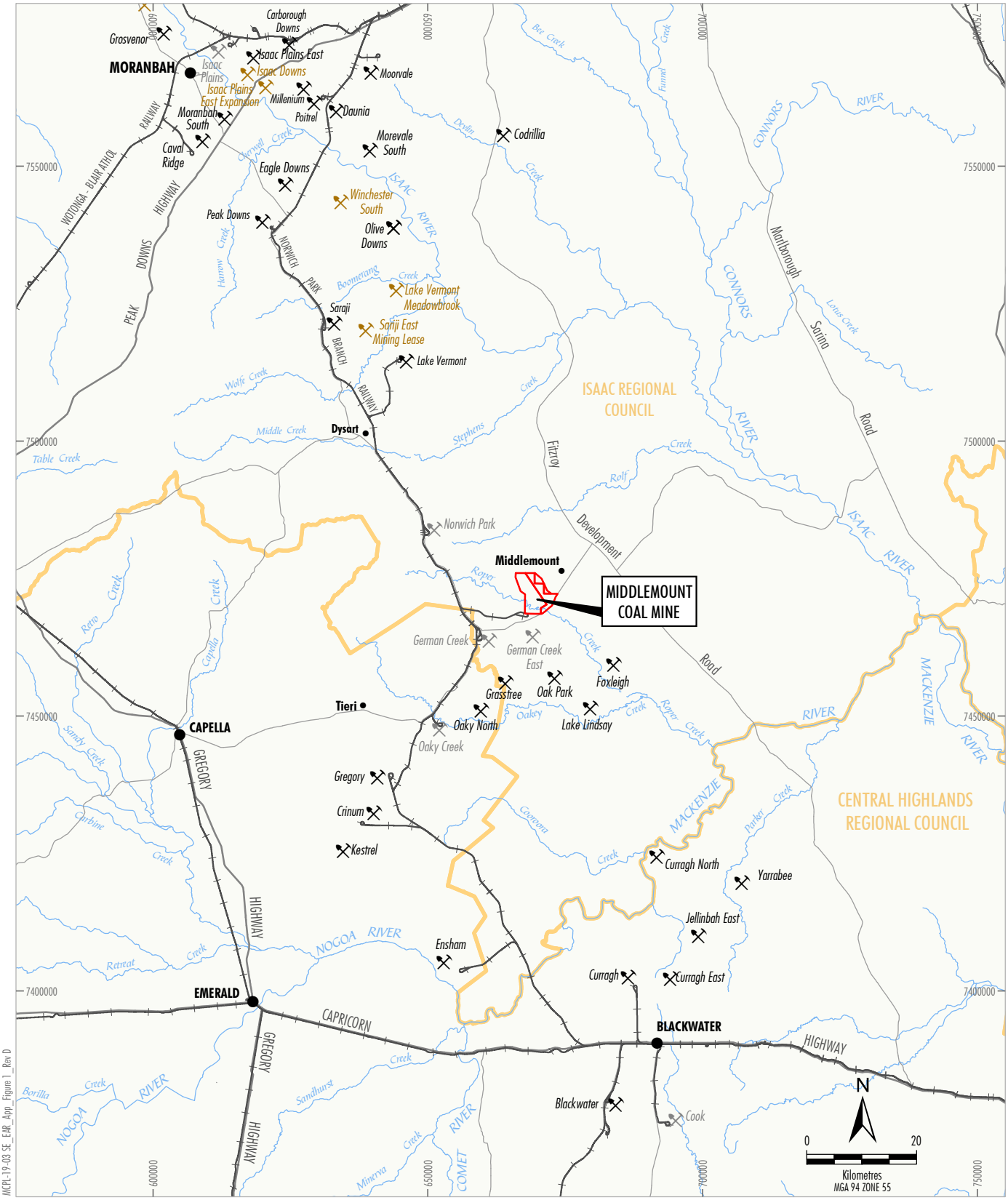
1.3 Purpose

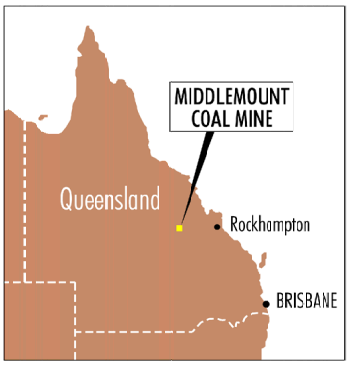
The purpose of the Aquatic Ecology Assessment is to describe the aquatic values of the Study area (shown in Figure 3) as relevant to current Commonwealth and State legislation, assess the impacts of the proposed actions on these values and present strategies to avoid, minimise or mitigate impacts to significant aquatic values. The Study area comprises the majority of the additional surface development area associated with the Project (Figure 2), and extends upstream along Roper Creek (Figure 3).

1.4 Scope of work

The scope of work for this aquatic ecology assessment includes the following tasks:

- conduct a desktop review of available literature and previous studies in the vicinity of the Study area, and conduct database searches for conservation significant aquatic species;
- undertake aquatic ecology surveys throughout the Study area using appropriate methodology to:
  - describe aquatic habitats and their value and importance, including features such as substrate, stream type, water quality condition, and surrounding land uses;
  - describe aquatic flora and fauna (including mammals, fish, reptiles and aquatic invertebrates) present, or likely to be present at any time of the year;
  - identify and describe any listed threatened aquatic species, and any introduced aquatic species, that are present or likely to be present in the Study area and identify their habitat resources;
  - consider relevant State and Commonwealth guidelines associated with threatened species likely to occur in the Study area;
  - identify and describe wetlands present, and their value and importance;
  - identify and describe subterranean and surface expression groundwater-dependent ecosystems (GDEs); and
- prepare an aquatic ecology assessment report that identifies the methods and results of the desktop and field studies, assesses the potential impacts of the Project, and present mitigation measures and any offset requirements.





LEGEND

- Mining Lease Boundary
- Local Government Area Boundary
- Approved/Operating Coal Mine
- Under Care and Maintenance
- Proposed Mining Operation

Source: The State of Queensland (2020)

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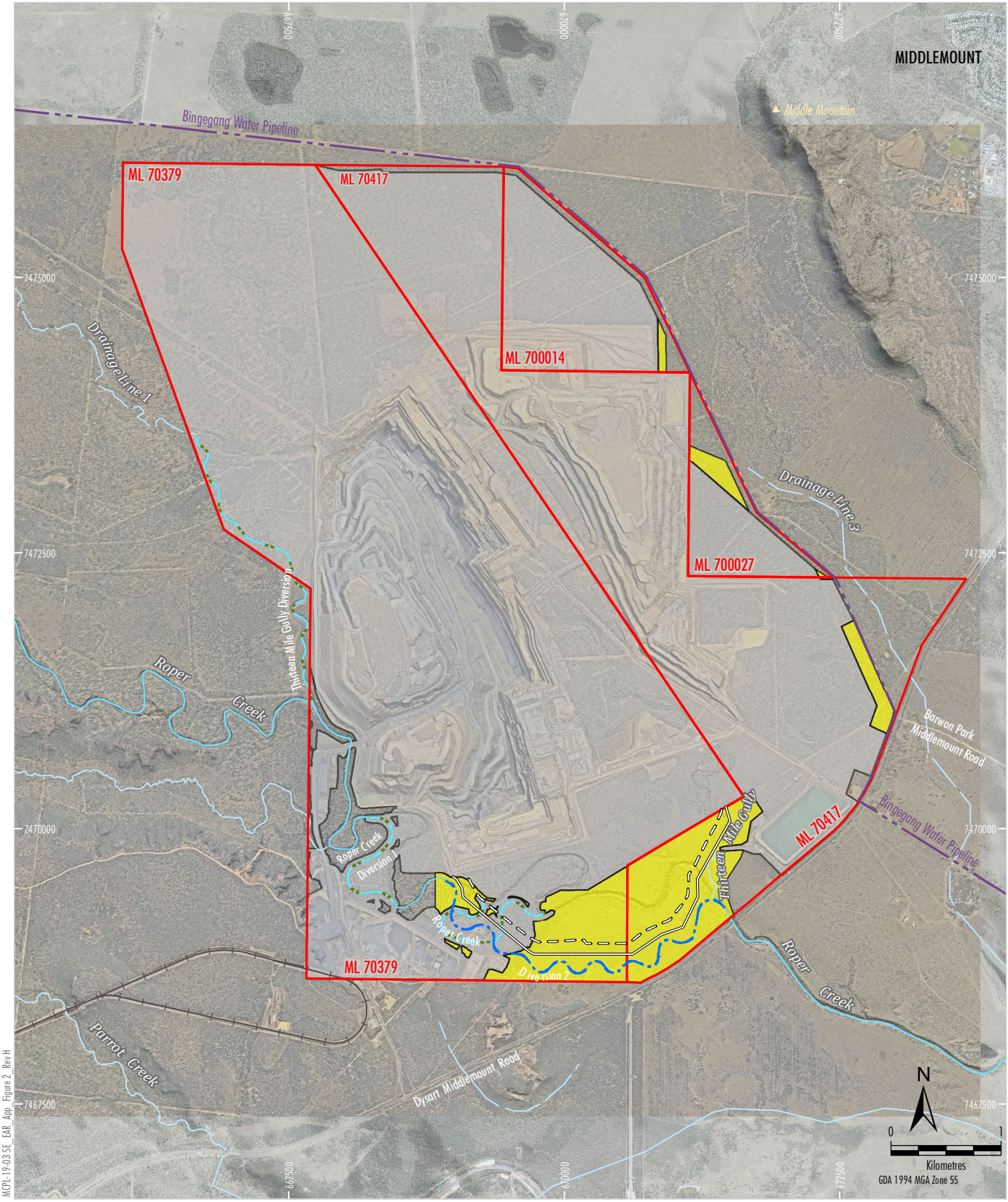
SOUTHERN EXTENSION PROJECT

Regional Location

Figure 1

MCPL-19-03 SE_EAR_App_Figure 1_Rev D



MCPL-19-03 SE_EAR_App_Figure 2_RevH

LEGEND

- Mining Lease Boundary (ML)
- Middlemount Rail Spur and Loop
- Approved Disturbance Footprint
- Approved Diversion Structure
- Realigned Diversion Structure
- Levee
- Open Cut Pit Extension
- Approximate Extent of Additional Disturbance

Source: MCPL (2020); The State of Queensland (2020)
Orthophoto: MCPL (September 2019)

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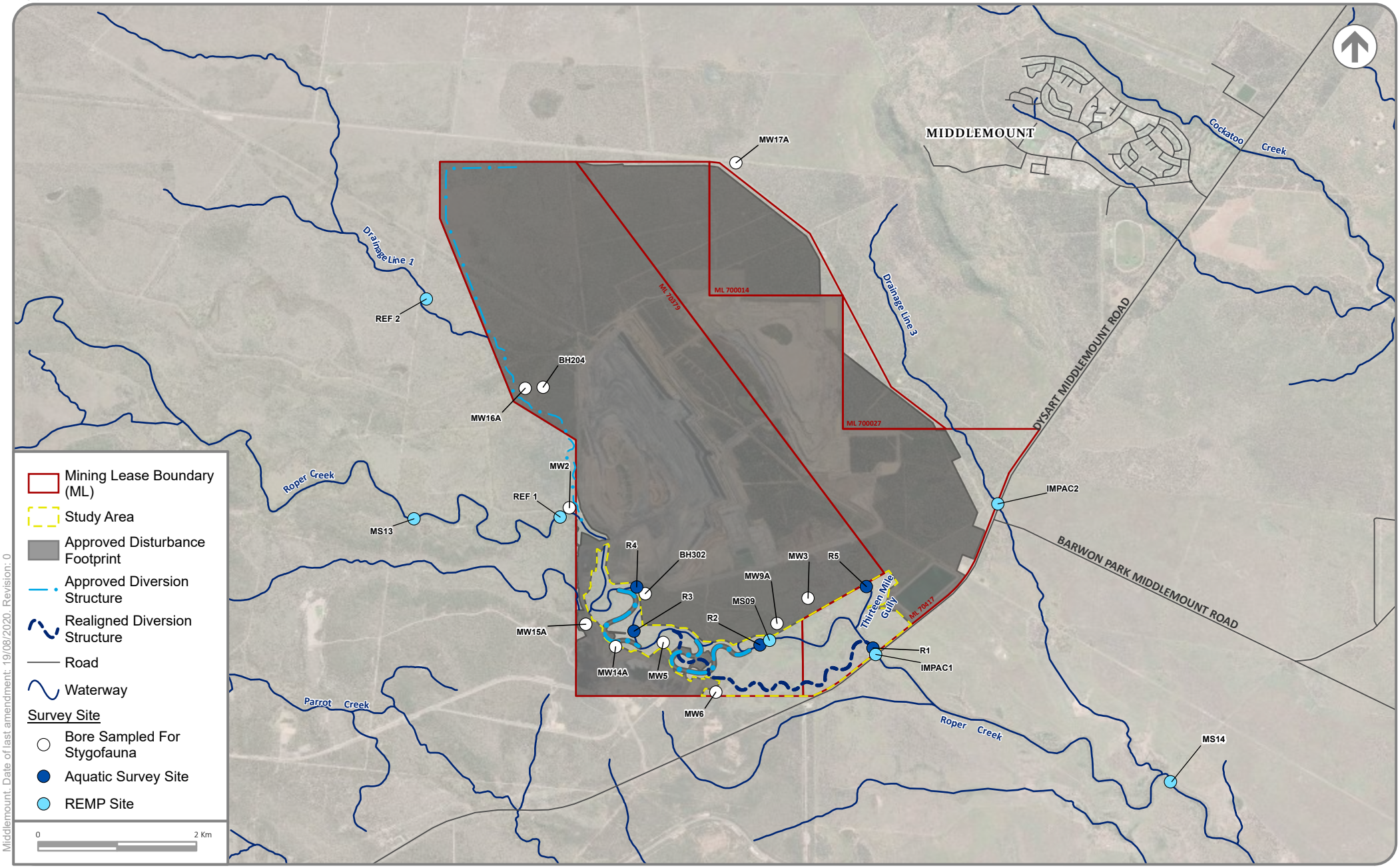
SOUTHERN EXTENSION PROJECT

Approximate Project Footprint

Figure 2



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STUDY AREA AND RELEVANT SAMPLING SITES

Middlemount Coal Mine Southern Extension Project

FIGURE 3

2 EXISTING ENVIRONMENT

2.1 Regional setting

The Study area is located within the Isaac Regional Council Local Government Area. It is approximately 6 km south-west of Middlemount and 40 km south east of Dysart within the Brigalow Belt Bioregion. The context of the Study area on a regional scale is shown in Figure 1.

2.2 Rainfall

The aquatic habitat in the Study area is subject to seasonality, which can be broadly categorised as either dry season or wet season. Rainfall across the Middlemount Coal Mine is expected to be greatest in mid-summer, with the lowest rainfall expected to occur in early spring, as inferred from data collected at the Booroondarra Bureau of Meteorology (BoM) monitoring station 35109 (BoM 2019) (Figure 4), located approximately 15 km west of the Middlemount Coal Mine. Rainfall records from the Middlemount Coal Mine meteorological station (active since 2008) also reflect this seasonality.

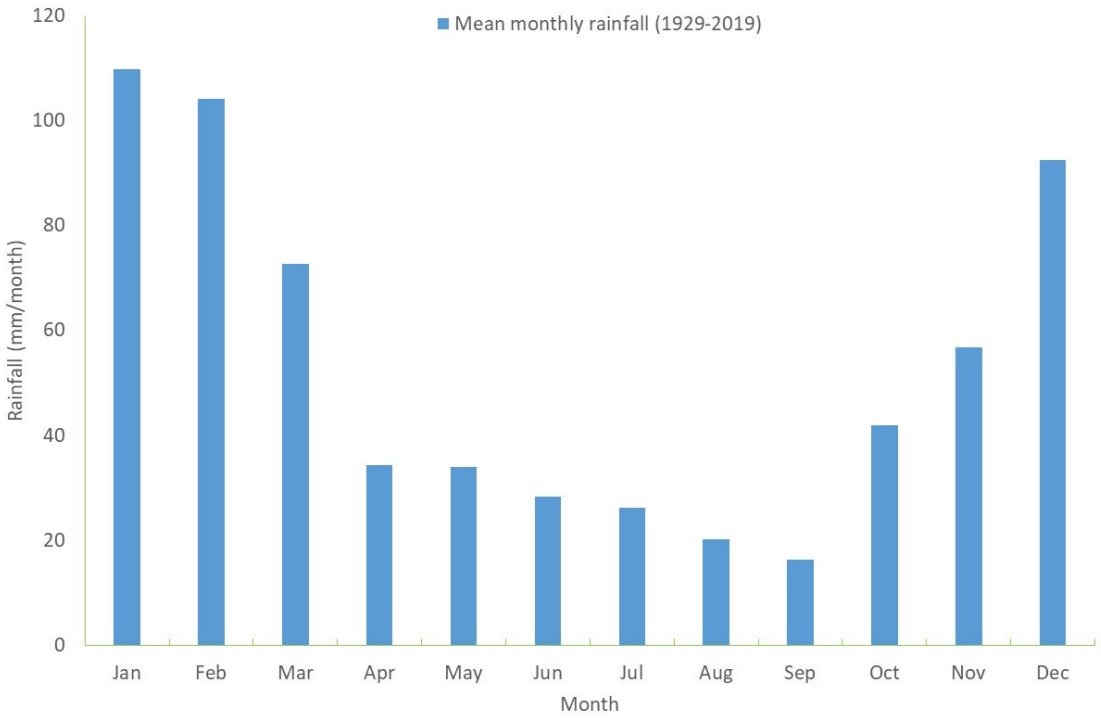


Figure 4 Historical rainfall at Booroondarra Meteorological Station 35109 (BoM 2019)

The waterways in the Study area (including Roper Creek and Thirteen Mile Gully) are ephemeral and experience flow only after sustained or intense rainfall in the catchment. Stream flows are highly variable, with most channels expected to dry out during winter to early spring when rainfall and runoff is historically low. During these times, aquatic fauna are likely to concentrate in senescing pools. As a consequence, physical attributes, water quality, and the composition of aquatic floral and faunal communities are expected to be highly variable over time.

2.3 Streamflow

From 1971 to 1988, the Queensland Government operated a streamflow gauge on Roper Creek at Barwon Park (Station No. 130107A), located approximately 28 km downstream of the Middlemount Coal Mine (WRM 2020). The total catchment area draining to the Barwon Park streamflow gauge is approximately 2,126 km^2 (WRM 2020), compared to approximately 389 km^2 for Roper Creek at the Middlemount Coal Mine (GHD 2019). Analysis of monthly runoff versus rainfall for Roper Creek at the Barwon Park stream gauge indicates that very little runoff is generated by the catchment for monthly rainfall below about 100 mm, and that once monthly rainfall exceeds about 200 mm, the volume of surface runoff increases substantially (WRM 2020). The stream flows recorded at Barwon Park provide a good indication of the behaviour of streamflow in Roper Creek following rainfall events, although it is noted that the magnitude of stream flows in Roper Creek at the Middlemount Coal Mine would be substantially less than that recorded at Barwon Park.

Since the waterways of the Study area are ephemeral and have sandy substrates, it is expected that most pooling water is unlikely to remain for longer than a few months without follow-up rainfall and runoff in the catchment.

MCPL operate a gauging station (Ref 1) on Roper Creek, just upstream of the Study Area (Figure 3). The gauging station was installed in December 2012 and data recording commenced in July 2014. Data from this gauging station demonstrate that only periodic flows are recorded in Roper Creek in response to rainfall runoff flow events, with flows then separated by long periods up to 11 months of essentially no flow (AGE 2018).

2.4 Land use

The Study area has been largely cleared through past agricultural practices; however, some tracts of remnant vegetation exist, particularly along the riparian corridor of Roper Creek.

The Study area is located within the Bowen Basin where open cut coal mining is a key land use. Coal and petroleum (e.g. coal seam gas) mining exploration activities have been conducted within the Study area and surrounds for decades, and continue.

3 METHODS

3.1 Taxonomic nomenclature

Scientific names of fauna used in this report follow the Commonwealth Scientific and Industrial Research Organisation (CSIRO) List of Australian Vertebrates (Clayton et al. 2006). Scientific names of flora used in this report follow the Australian Plant Census (CHAH 2014).

3.2 Determination of significance level

Endangered, Vulnerable or Near Threatened (EVNT) species are defined as those taxa listed in the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) or Queensland *Nature Conservation Act 1992* (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 (BoT) Actions for Biodiversity for the Fitzroy NRM Region (Queensland Department of Environment and Resource Management [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 Special Least Concern (SLC) or Least Concern (LC) under the NC Act.

3.3 EVNT species likelihood of occurrence

EVNT species identified from the desktop assessment (and subsequent field surveys) were assigned a likelihood of occurrence based on the criteria identified in Table 1. Targeted searches were undertaken in the field for species identified as either being likely to occur, or having potential to occur within the Study area, based on the desktop sources. The methodology was applied again after surveys to determine the likelihood of occurrence once site-based information became available.

Table 1 Criteria adopted for the likelihood of EVNT species, identified from the desktop assessment, occurring within the Study area

Likelihood of occurrence	Criteria
Unlikely	▪ species or species habitat may occur, is likely to occur or is known to occur from the broader search area (based on database searches); but ▪ preferred habitat has not been identified within the Study area; and ▪ there are no confirmed species records within 10 km of the Study area. ▪ preferred habitat occurs within the Study area, but there are no confirmed species records within 50 km of the Study area.
Potential	▪ species or species habitat may occur, is likely to occur or is known to occur from the broader search area (based on database searches); and ▪ preferred habitat occurs within the Study area; and ▪ there are no confirmed species records within 10 km of the Study area; however, there are confirmed species records within 50 km of the Study area; OR ▪ species indicated as likely during desktop assessment, but field surveys revealed no evidence of occurrence in the Study area.
Likely	▪ preferred habitat occurs within the Study area; and ▪ confirmed species records within 10 km of the Study area; however ▪ species not yet confirmed as occurring within the Study area.
Known	▪ confirmed species records within the Study area (generally as a result of subsequent field survey).

3.4 Desktop assessment

3.4.1 Surface aquatic ecosystems

Desktop searches were undertaken in September 2019 (and revised in 2020 where relevant). This included a review of the following:

- Department of the Environment and Energy (DEE), EPBC Act Protected Matters Search Tool, to identify aquatic Matters of National Environmental Significance (MNES) within approximately 10 km of the Study area (Appendix A) (DEE 2020a).
- Department of Environment and Science (DES), mapping of Matters of State Environmental Significance (MSES) (DES 2019a), to identify aquatic matters of state interest under the State Planning Policy 2017 (SPP).
- DES (2019b) Queensland Wetland Data Version 5 series – Queensland Wetlands Map (DES 2019b), to determine the classification, extent and significance of lacustrine, palustrine and riverine systems within the Study area.
- DES (2020a) Wetland*Info* Wetland Summary Information (including species listings) for the Fitzroy Basin, incorporating data from the DES Wildlife Online database, Queensland Museum and Queensland Herbarium.
- Atlas of Living Australia (ALA) (2020), to interrogate existing species records.
- Queensland Waterways for Waterway Barrier Works mapping 2016 (Queensland Department of Agriculture and Fisheries [DAF] 2019).
- Queensland Groundwater Dependent Ecosystems (GDE) and Potential GDE Aquifer Mapping 2018 (DES 2019c).
- The Fitzroy Natural Resource Management Region Back-on-Track Actions for Biodiversity (Queensland Department of Environment and Resource Management [DERM] 2010).
- Aquatic Conservation Assessments (ACAs) for the riverine (Inglis and Howell 2009) and non-riverine (Rollason and Howell 2012) wetlands of the GBR catchment.
- Published ecological information on EVNT and SLC aquatic flora and fauna species.
- Previous studies relating to the Middlemount Coal Mine and adjoining mines, including:
  - Middlemount Coal Mine Western Extension Project Environmental Assessment Report (MCPL 2018);
  - Middlemount Coal Pty Ltd Middlemount Stygofauna Pilot Study Data Report (GHD 2013);
  - Middlemount Coal Mine Western Extension Project: Groundwater Assessment (AGE 2018);
  - Middlemount Coal REMP 2019 monitoring report, prepared for Middlemount Coal Pty Ltd (GHD 2019); and
  - Middlemount Coal Project EIS, Stage 2: Aquatic Ecology (FRC Environmental 2010).
- Relevant survey guidelines, including:
  - the Australian River Assessment System (AusRivAS) protocols for Queensland streams (Queensland Department of Natural Resources and Mines [DNRM] 2001); and
  - *Information Guidelines Explanatory Note: Assessing groundwater-dependent ecosystems*. Report prepared for the Independent Expert Scientific Committee on Coal Seam Gas and Large Coal Mining Development through the Department of the Environment and Energy, Commonwealth of Australia 2019 (Doody TM, Hancock PJ, Pritchard JL 2019).

3.4.2 Stygofauna

A desktop review was conducted to assess the likely presence and composition of subterranean aquatic faunal communities in the Study area and the likely degree of impact on subterranean aquatic fauna from proposed activities. This included a review of:

- the Queensland *Guideline for the Environmental Assessment of Subterranean Aquatic Fauna* (Queensland Department of Science, Information Technology and Innovation [DSITI] 2015); and
- the *Monitoring and Sampling Manual: Environmental Protection (Water) Policy* (DES 2018).

The desktop review involved:

- assessing the suitability of local habitat for subterranean aquatic fauna based on local geological and hydrological conditions; and
- determining the presence and composition of subterranean aquatic fauna in the region and Project locality based on previous studies.

3.5 Field survey of surface aquatic ecosystems

3.5.1 Survey timing and site selection

A dry season survey was undertaken across the Study area by DPM Envirosciences 14-16 October 2019, aligning with the AusRivAS 'early wet' sampling season (October to December). No surface water was encountered within the Study area during the October 2019 surveys. Follow-up wet season surveys were undertaken 18-21 Feb, four weeks following substantial rainfall in mid-January that produced high flows (but not flooding) in Roper Creek.

Desktop investigations, including review of available aerial imagery and review of the Queensland Wetlands Map (DES 2019b), were used to identify representative stream reaches for field assessment. Detailed aquatic survey was attempted at five locations (Figure 5), comprising:

- five riverine system drainage lines:
  - four stream order 4 sites (Roper Creek); and
  - one stream order 2 site (Thirteen Mile Gully).

No wetlands are mapped as occurring with the Study area.

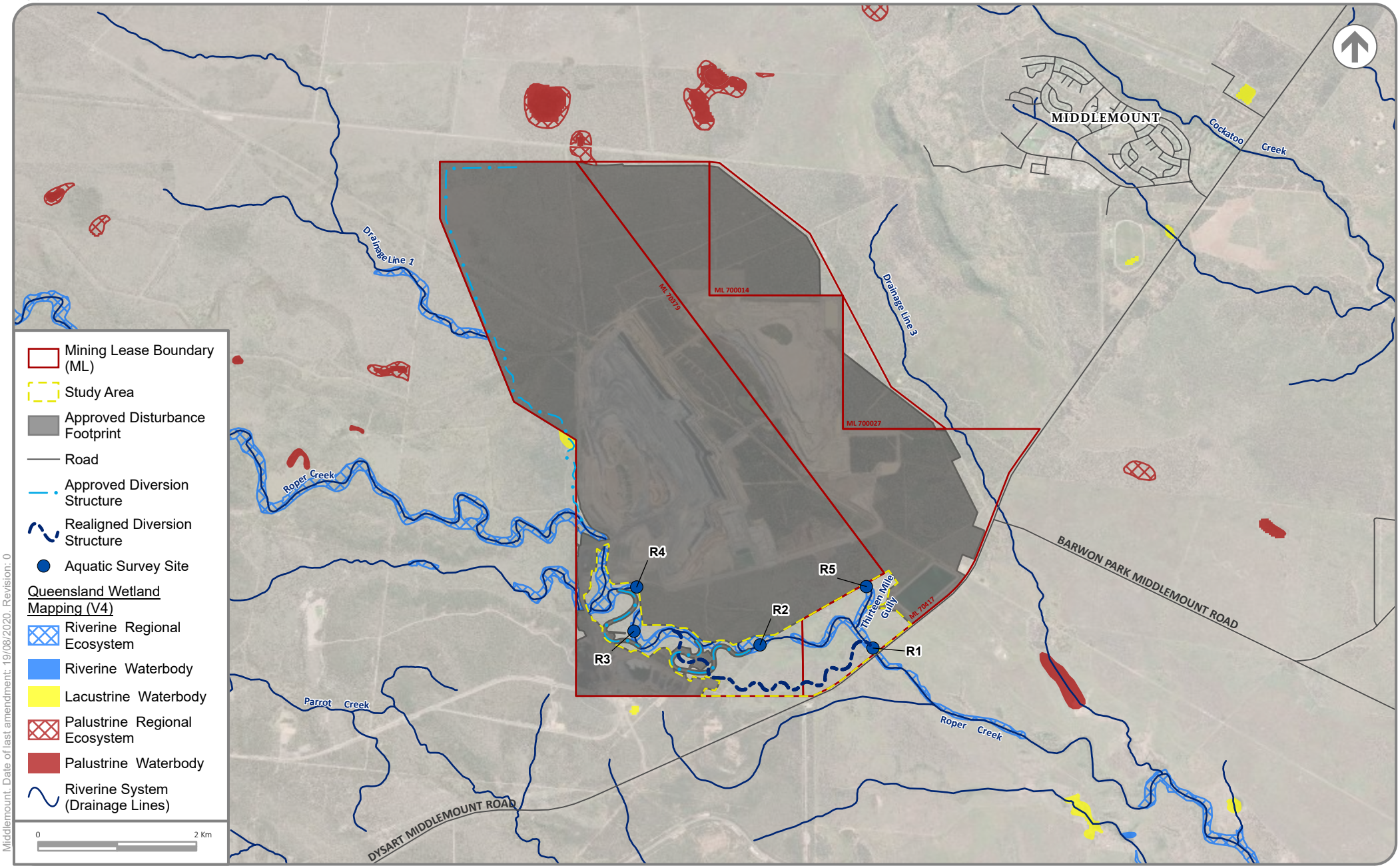
The sampling sites and survey effort are identified in Table 2.

3.5.2 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.

Habitat assessment scores (out of 135) were made for each site based on the nine AusRivAS categories (Table 3). 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 B.



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WATERWAYS AND WETLANDS OF THE STUDY AREA AND SURROUNDS

Middlemount Coal Mine Southern Extension Project

FIGURE 5

Table 2 Survey effort for surface aquatic ecosystems of the Study area

Site	Site ID	Date	Stream order (Strahler)	Lat. (GDA 1994)	Long. (GDA 1994)	Fish survey effort			Turtle survey effort		Aquatic macro-invert. sampling		Water quality	Aquatic flora survey	Habitat assess.
						Electro-fishing	Fyke nets	Box traps	Cathedral traps	Fyke nets	Bed habitat	Edge habitat			
Dry season survey															
Roper Creek	R1	14/10/19	4	-22.8758	148.6715	Dry								✓	✓
Roper Creek	R2	14/10/19	4	-22.8754	148.6575	Dry								✓	✓
Roper Creek	R3	14/10/19	4	-22.8737	148.6417	Dry								✓	✓
Roper Creek	R4	14/10/19	4	-22.8681	148.6420	Dry								✓	✓
Thirteen Mile Gully	R5	14/10/19	2	-22.8681	148.6705	Dry								✓	✓
Wet season survey															
Roper Creek	R1	18/02/20	4	-22.8758	148.6715	✓	✓	✓	-	✓	✓	✓	✓	✓	✓
Roper Creek	R2	19/02/20	4	-22.8754	148.6575	✓	✓	✓	-	✓	✓	✓	✓	✓	✓
Roper Creek	R3	18/02/20	4	-22.8737	148.6417	✓	✓	✓	-	✓	✓	✓	✓	✓	✓
Roper Creek	R4	18/02/20	4	-22.8681	148.6420	✓	-	-	-	-	✓	✓	✓	✓	✓
Thirteen Mile Gully	R5	19/02/20	2	-22.8681	148.6705	Dry								✓	✓

Notes:

Water depth at site R4 too shallow for deployment of fyke nets or box traps. Water depth at sites R1-R4 too shallow for deployment of cathedral traps.

Table 3 Aquatic habitat assessment variables and categories

Habitat variable	Poor	Fair	Good	Excellent
Bottom substrate / available cover	0 – 5	6 – 10	11 – 15	16 – 20
Embeddedness	0 – 5	6 – 10	11 – 15	16 – 20
Velocity / depth category	0 – 5	6 – 10	11 – 15	16 – 20
Channel alteration	0 – 3	4 – 7	8 – 11	12 – 15
Bottom scouring and deposition	0 – 3	4 – 7	8 – 11	12 – 15
Pool / riffle, run / bend ratio	0 – 3	4 – 7	8 – 11	12 – 15
Bank stability	0 – 2	3 – 5	6 – 8	9 – 10
Bank vegetative stability	0 – 2	3 – 5	6 – 8	9 – 10
Streamside cover	0 – 2	3 – 5	6 – 8	9 – 10
Total	**0 – 38**	**39 – 74**	**75 – 110**	**111 – 135**

3.5.3 Water quality

No surface water was encountered during the October 2019 dry season survey. As such, no dry season water quality measurements were obtained.

In-situ water quality

In-situ water quality measurements were obtained in February 2020 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 also assessed to assist in characterising surface waters of the Project site, including their likely interaction with groundwater.

In-situ measurements

In-situ water quality parameters were measured at each wetted survey site using a YSI Professional Plus multi-parameter water quality meter and an 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); and
- dissolved oxygen (mg/L and % saturation).

For the purposes of this assessment, salinity descriptors are based on the following EC ranges (Department of Agriculture, Fisheries and Forestry [DAFF] 2012):

- fresh – <800 µS/cm;
- marginal – 800 to 1,600 µS/cm;
- brackish – 1,600 to 4,800 µS/cm;
- slightly saline – 4,800 to 10,000 µS/cm;
- moderately saline – 10,000 to 20,000 µS/cm; and
- saline – >20,000 µS/cm.

Major 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 Project site:

- major anions (Cl, SO4, F and Alkalinity); and
- major cations (Ca, Mg, Na and K) and hardness.

Duplicate and field blank samples were collected and analysed for quality assurance purposes to demonstrate sampling integrity.

Data analysis

In-situ water quality measurements were compared against Water Quality Objectives (WQOs) for developed areas of the Mackenzie north-western tributaries 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 2011).

Quality assurance / quality control

Quality assurance / quality control (QA/QC) measures included the collection and analysis of a field duplicate sample to confirm the analytical reliability of the laboratory results, and a field blank to confirm the reliability of field handling procedures, to demonstrate that no cross-contamination had occurred.

Relative Percent Differences (RPDs) between the sample and duplicate analytes were calculated. The Queensland *Monitoring and Sampling Manual* (DES 2018) stipulates that an acceptable RPD of ≤ 20% between field duplicate sample concentrations generally indicates an acceptable result for aqueous samples where the result is five to ten times the Limit of Reporting (LOR). In those instances where the result is close to the LOR, the RPD may exceed 20% (DES 2018).

Field blanks were prepared in the same manner as the samples, but using deionized water. Results were reviewed with the expectation that all analytes will be below or close to the LOR.

3.5.4 Fish

No surface water was encountered in the October 2019 dry season survey. As such, no dry season fish survey was undertaken. Instead, habitat assessment was undertaken to infer habitat usage in times of flow.

Fish were surveyed at four wetted sites (R1, R2, R3 and R4) in February 2020 using a combination of backpack electrofishing, dip-netting, and overnight deployment of baited box traps and fyke nets where sufficient depth was encountered.

Fish survey effort employed at most fished sites (exceptions indicated below) included:

- backpack electrofishing using a Smith-Root LR-24 electrofisher for up to 1200 seconds power-on time (100Hz frequency; 20% duty cycle; 300-350v, 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 metres (m) wing lengths, 0.6 m drop, 3 millimetre (mm) mesh, baited with beef heart, rinsed sardines, banana and apple – deployed overnight to capture active fish (and turtles); and

- 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.

Fish survey at site R4 was restricted to backpack electrofishing and dip-netting, due to insufficient depth for deployment of fyke nets or box traps. However, this survey reach was thoroughly fished using backpack electrofishing techniques.

Captured fish were identified, with native species released at the point of capture. No pest fish species were encountered.

3.5.5 Turtles

No surface water was encountered in the October 2019 dry season survey. As such, no dry season turtle survey was undertaken. Instead, habitat assessment was undertaken to infer habitat usage in times of flow.

The Survey Guidelines for Australia's Threatened Reptiles (Department of Sustainability, Environment, Water, Population and Communities [DSEWPC] 2011) 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 also 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 in DSEWPC 2011, 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 (Eyre et. al. 2014) suggest that freshwater turtle surveys should employ one or more of the following capture techniques:

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

Freshwater turtles were surveyed at sites (R1, R2 and R3) by overnight deployment of baited fyke nets. Searches for turtles at sites R1, R2, R3 and R4 included 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.

Water clarity was too poor to enable snorkelling surveys at any sites.

3.5.6 Platypus

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

3.5.7 Aquatic macroinvertebrates

Aquatic macroinvertebrate sampling was undertaken only in the February 2020 wet season survey, since no surface water was encountered in the October 2019 dry season survey. Aquatic macroinvertebrate samples were collected from suitable habitat at sites R1, R2, R3 and R4 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 each site in accordance with AusRivAS protocols.

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 an AusRivAS accredited taxonomist 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, due to the absence of these pollution-sensitive taxa, suggests that a site may be impacted by degradation or pollution. 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 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 low scores are most tolerant of a range of environmental conditions, and those with high scores 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).

3.5.8 Aquatic flora

Aquatic plants were surveyed at each site (100 m reach) in both October 2019 and February 2020. 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%).

3.5.9 Aquatic values ratings

An aquatic values rating of High, Moderate or Low was assigned to each site based on the summation of all available information from the desktop and field assessments (Table 4). When assessing each site the overall aquatic value criteria that fit the situation best is applied. The criteria in Table 4 are listed from most to least important.

Table 4 Adopted criteria for assigning aquatic values ratings

Aquatic Values / Sensitivity	Criteria
High	▪ Semi-permanent or permanent waterbody
	▪ Wetland of High Ecological Significance
	▪ EVNT species habitat present
	▪ Known presence of platypus breeding place
	▪ Near natural / excellent in-stream habitat
	▪ Excellent habitat bioassessment score (111 – 135)
Moderate	▪ Ephemeral or semi-permanent waterbody
	▪ Wetland of General Ecological Significance
	▪ Priority flora species cover moderate or extensive
	▪ Priority fauna species present
	▪ Platypus habitat present
	▪ Some good quality in-stream habitat
	▪ Regional conduit for fish passage (mapped major / high)
	▪ Good habitat bioassessment score (75 – 110)
	▪ Dry season refuge for common (Least Concern) species
Low	▪ Ephemeral waterbody
	▪ No EVNT species or platypus habitat
	▪ In-stream habitat highly modified / disturbed
	▪ Poor to Fair habitat bioassessment score (0 – 74)

3.6 Field survey of stygofauna

3.6.1 Consideration of bores for sampling

A review of the Queensland Department of Natural Resources, Mines and Energy (DNRME) (2019) groundwater database and the *Middlemount Coal Mine Western Extension Project Groundwater Bore Census* (4T 2012, appended to AGE 2020) identified 44 bores within 10 km of the Study Area. This includes mine monitoring bores installed within and surrounding the Middlemount Coal Mine in 2008, 2012, 2015 and 2019, mine monitoring bores associated with Foxleigh Plains Mine to the east and German Creek Grasstree Mine to the south, landfill monitoring bores at Middlemount, and private landholder bores to the north.

Bore reports and available bore construction logs were reviewed to assess the suitability of bores for sampling and their likelihood of containing stygofauna.

The *Guideline for the Environmental Assessment of Subterranean Aquatic Fauna* (DSITI 2015) requires that bores sampled for stygofauna be at least six months old. The *Information Guidelines Explanatory Note: Assessing Groundwater-dependent Ecosystems* (Doody, Hancock and Pritchard 2019) identifies characteristics of bores most likely to yield stygofauna, including slot widths of at least 1 mm wide in the screened interval to allow entry of larger taxa such as amphipods. It is noted that some bores incorporate slot widths of 1 mm into the screened interval, and some incorporate slot widths of only 0.5 mm, but were still the best available option for sampling (Table 5).

4T Consultants Pty Ltd (4T 2012) prepared a desktop assessment of at least 13 stygofauna studies in Queensland and established water quality conditions in which stygofauna were more likely to be found. In fractured rock, stygofauna were more likely where the aquifer was <50 metres below ground level (mbgl), pH 6.5-8.5 and Electrical Conductivity <5,000 µS/cm (4T 2012). In alluvium, stygofauna were more likely where the aquifer was <20 mbgl, pH 6.5-8.5 and EC <2,000 µS/cm (4T 2012). Bores with these characteristics, or similar, were prioritised for field sampling.

Table 5 Characteristics of groundwater monitoring bores considered suitable for stygofauna sampling

Bore ID^	Registered number	Lithology at screened interval	Inferred aquifer type / age	Casing diameter (mm)	Bore depth (mBGL)	Screen interval (mBGL)	Screen aperture size (mm)	SWL (mBGL) *	pH	EC (µS/cm)
MW2^	151043	Sandy clay and sand	Tertiary	50	30.0	21.0-29.0	-	20.77	7.4	2772
MW3	151336	Clay and sandy clay		50	48.0	39.0-47.0	-	-	-	-
MW6	132459	Clay		50	42.0	37.0-42.0	-	23.3	-	-
MW9A	161064	Sandstone and siltstone		50	52.0	40.0-52.0	0.5	-	-	-
MW11A	NR	Clay and mudstone		50	13.5	10.5-13.5	-	-	-	-
MW14A	NR	Sand, clayey sand and mudstone		50	14.0	6.0-9.0	-	-	-	-
MW15A	NR	Sand, sandy clay and mudstone		50	12.5	7.0-10.0	-	-	-	-
BH302	187170	Sandstone		50	41.0	28.1-31.0	0.5	24.1	6.8	3900
BH203	187165	Sandstone		150	50.0	44.0-50.0	0.5	21.8	6.7	2050
BH204	187169	Sandy clay and mudstone		50	50.0	37.5-43.5	0.5	24.5	6.9	2750
BH202	187168	Sand and clay		50	44.2	14.0-17.0	0.5	12.8	6.8	3020
MW4^	151335	Weathered igneous rock, coal and sandy coal	Permian	50	50.0	41.0-50.0	-	37.12	7.12*	23151*
MW5^	151658	Coal		50	46.0	40.0-46.0	-	17.62	6.38*	763*
MW17A	NR	Claystone and sandstone		50	43.0	36.5-42.5	-	-	-	-

Notes:

^ Indicates bores in which subterranean fauna were detected by GHD in 2012 (GHD 2013); * Indicative level represented by either as drilled or standing water level in developed bore in subsequent sampling; NR = Not Registered.

3.6.2 Field sampling

In-situ water quality

A groundwater sample was retrieved from each bore using a disposable groundwater bailer immediately prior to stygofauna sampling. EC and pH were measured using a YSI Professional Plus multi-parameter water quality meter, calibrated prior to and following sampling.

For the purposes of this assessment, the measure of salinity is based on the following EC ranges (DAFF 2012):

- fresh – water with EC <800 µS/cm;
- marginal – 800 to 1,600 µS/cm;
- brackish – 1,600 to 4,800 µS/cm;
- slightly saline – 4,800 to 10,000 µS/cm;
- moderately saline – 10,000 to 20,000 µS/cm; and
- saline – >20,000 µS/cm.

Stygofauna

Stygofauna sampling was undertaken in accordance with the *Monitoring and Sampling Manual* (DES 2018). Three sizes of phreatobiological nets were carried in the field for stygofauna sampling, with diameters of 40 mm, 90 mm and 130 mm. Nets were constructed of 50 µm monomesh and weighted at the bottom. The nets tapered to a removable collection chamber at the base, allowing ease of collection for replicate samples following each haul. Nets were lowered to the bottom of the bore, bounced five to ten times to dislodge resting animals, then retrieved. The collection chamber was rinsed into a 50 µm mesh sieve at the top of each haul. Once five hauls were completed, the entire sieve contents were transferred to a labelled sample jar and preserved in ethanol.

Nets were washed thoroughly three times in deionised water between sampling locations.

3.6.3 Sample processing

Field samples were sorted in the laboratory under a stereomicroscope. Each sample container was drained of ethanol and washed into a channelled counting tray to create a thin layer of sediment spread across the bottom of the tray. Aquatic animals were picked under the stereomicroscope. Samples yielding aquatic animals were placed in labelled, polyethylene containers filled with ethanol and sent to Dr Peter Hancock for specialist identification.

3.6.4 Personnel

Field sampling was conducted by David Moore, an aquatic ecologist with over 15 years' experience on both surface water and groundwater projects across Australia, including stygofauna sampling. Laboratory processing was undertaken by Chris Pietsch, an aquatic ecologist with 14 years' experience in aquatic assessments across Australia, including processing of stygofauna samples. Taxonomic identifications of stygofauna were undertaken by Dr Peter Hancock, an aquatic and groundwater ecologist with over 25 years of experience.

3.7 Framework for assessing GDEs

The assessment of aquatic and subterranean GDEs followed the framework identified in the *Information Guidelines Explanatory Note: Assessing Groundwater-dependent Ecosystems* (Doody, Hancock and Pritchard 2019). Sections of the framework addressed by this report are shown in Table 6.

Table 6 Framework for assessing GDEs in an environmental impact assessment

Step	Section in this report
Define the project impact area, including the footprint of surface infrastructure and the extent of groundwater depressurisation	Section 2
Undertake a desktop assessment to identify potential GDEs and potential risks to GDEs in the project impact area	Section 4.9
Assess the level of groundwater dependence for each GDE and the potential pathways of cause and effect	Section 4.9
Identify the baseline ecological condition and value of each GDE	Section 4.9
Assess the likelihood, frequency and magnitude of potential impacts on GDEs and determine the risks related to the activity	Section 4.9
Prioritise options to avoid or mitigate impacts on GDEs and establish a monitoring plan to test the effectiveness of mitigation strategies.	Not applicable (Section 4.9)

3.7.1 Ecological value of GDEs

Ecological value ratings were assigned to relevant GDEs following the *Risk Assessment Guidelines for Groundwater Dependent Ecosystems* (Serov, Kuginis and Williams 2012), as referred to in the *Information Guidelines Explanatory Note: Assessing Groundwater-dependent Ecosystems* (Doody, Hancock and Pritchard 2019).

Table 7 Criteria adopted for assigning GDE ecological values ratings (based on Serov et al. 2012)

Ecological value	Criteria
High	▪ GDE communities (including stygofauna) where only slight changes in key groundwater attributes below or above a threshold would result in their loss; i.e. entirely dependent ecosystems.
	▪ GDEs or aquifers that are partly or wholly located within a State or Federal Reserve System; e.g. National Park / Reserve, or a high conservation area.
	▪ Any GDE or aquifer that is relatively unaltered and in good condition.
	▪ Any natural GDE that is habitat for any endemic, relictual, rare or endangered biota (fauna or flora), populations or communities as listed under State or Commonwealth legislation or identified as above by an acknowledged expert taxonomist / ecologist.
Moderate	▪ GDE communities where moderate change in groundwater discharge or water tables is required to cause change in their distribution, composition and / or health (the value is based on the potential vulnerability / sensitivity to change).
	▪ Any natural GDE systems that is habitat for any vulnerable or threatened biota (fauna or flora), populations or communities as listed under State or Commonwealth legislation.
	▪ Any GDE or aquifer that provides ecological services to other ecosystems such as rivers, wetlands and estuaries.
	▪ GDE communities that exhibit either a threshold or proportional response to changes in groundwater attributes. Moderate systems can include highly dependent systems which can exhibit a threshold response.

Ecological value	Criteria
	▪ Any GDE or aquifer that is regarded as in moderate to good condition from its natural state but not covered by state or federal legislation.
	▪ Ecosystems where groundwater appears only to play a minor role in the water balance of such ecosystems such as at the end of a dry season or during extreme drought.
Low	▪ Any aquifer or GDE type that is highly modified from that of its natural state (that don't otherwise contain High or Moderate value attributes).
	▪ Would likely involve a high cost to rehabilitate, if even possible, and there are other similar GDE types in moderate to good condition; i.e. have little need of rehabilitation, existing within the catchment / aquifer.

4 RESULTS – AQUATIC ECOLOGY CHARACTERISTICS OF THE STUDY AREA

4.1 Waterways

The Queensland Wetlands Map (DES 2019b) identifies riverine systems, watercourses, waterways or drainage lines (here referred to collectively as waterways) for the Study area. There are three waterways mapped within the Study area, comprising:

- Roper Creek – stream order 4;
- Thirteen Mile Gully – stream order 2; and
- an unnamed tributary of Roper Creek – stream order 1.

The waterways of the Study area are ephemeral, only flowing after largely unpredictable rainfall and runoff, ceasing to flow within days, hence supporting aquatic life whose life cycles are adapted to these conditions. The DNRME (2019) Watercourse Identification Map 2018 is shown on Figure 6.

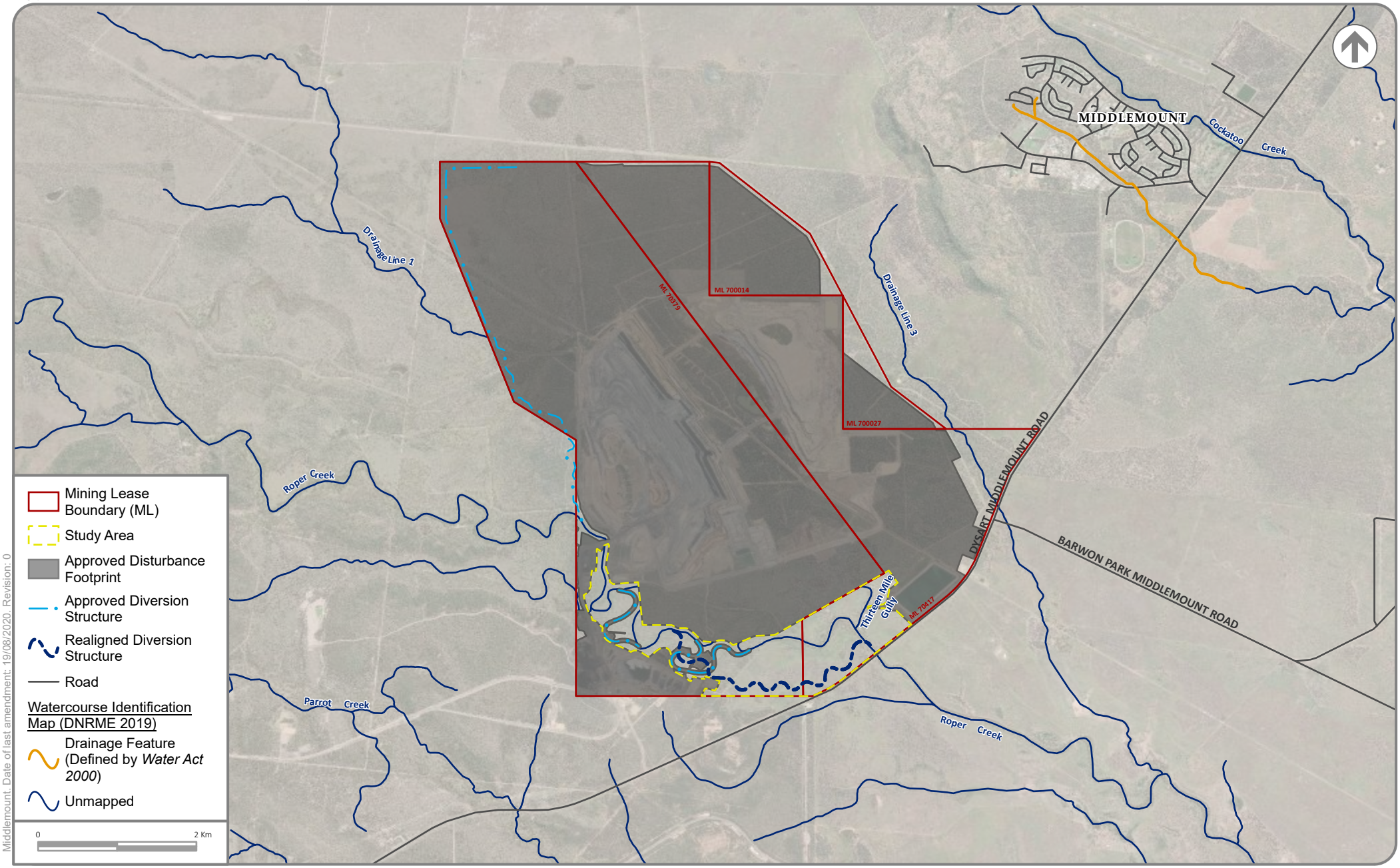
The Aquatic Biodiversity Assessment and Mapping Method (AquaBAMM) (Clayton et al. 2006), was developed to assess conservation values of wetlands and waterways in Queensland. It is a comprehensive method that uses available data (including data resulting from expert opinion), to identify relative non-social, 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 DERM) is a product of applying this method. The ACA data for the Study area identifies the waterways to be of medium conservation value. No wetlands are identified within the Study area. These data are shown in Figure 7.

4.1.1 Waterways for fish passage

Waterways, as defined by the *Fisheries Act 1994*, include rivers, creeks, streams, watercourses or inlets of the sea. The upstream limits of waterways are identified by Peterken et al. (2009) as including features relevant to fisheries resources, such as the following physical and hydrological attributes:

- defined bed and banks – the bed and banks need to be continuous rather than isolated and broken sections of a depression;
- an extended, if non-permanent, period of flow – flow must continue for a reasonable period after rain ceases and have some reliability commensurate with rainfall; and
- flow adequacy – the flow needs to be sufficient to sustain basic ecological processes and to maintain biodiversity within the feature.

The DAF (2019) *Queensland Waterways for Waterway Barrier Works 2016* mapping (Figure 8) 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 obtain a higher level of risk (DAFF 2013).



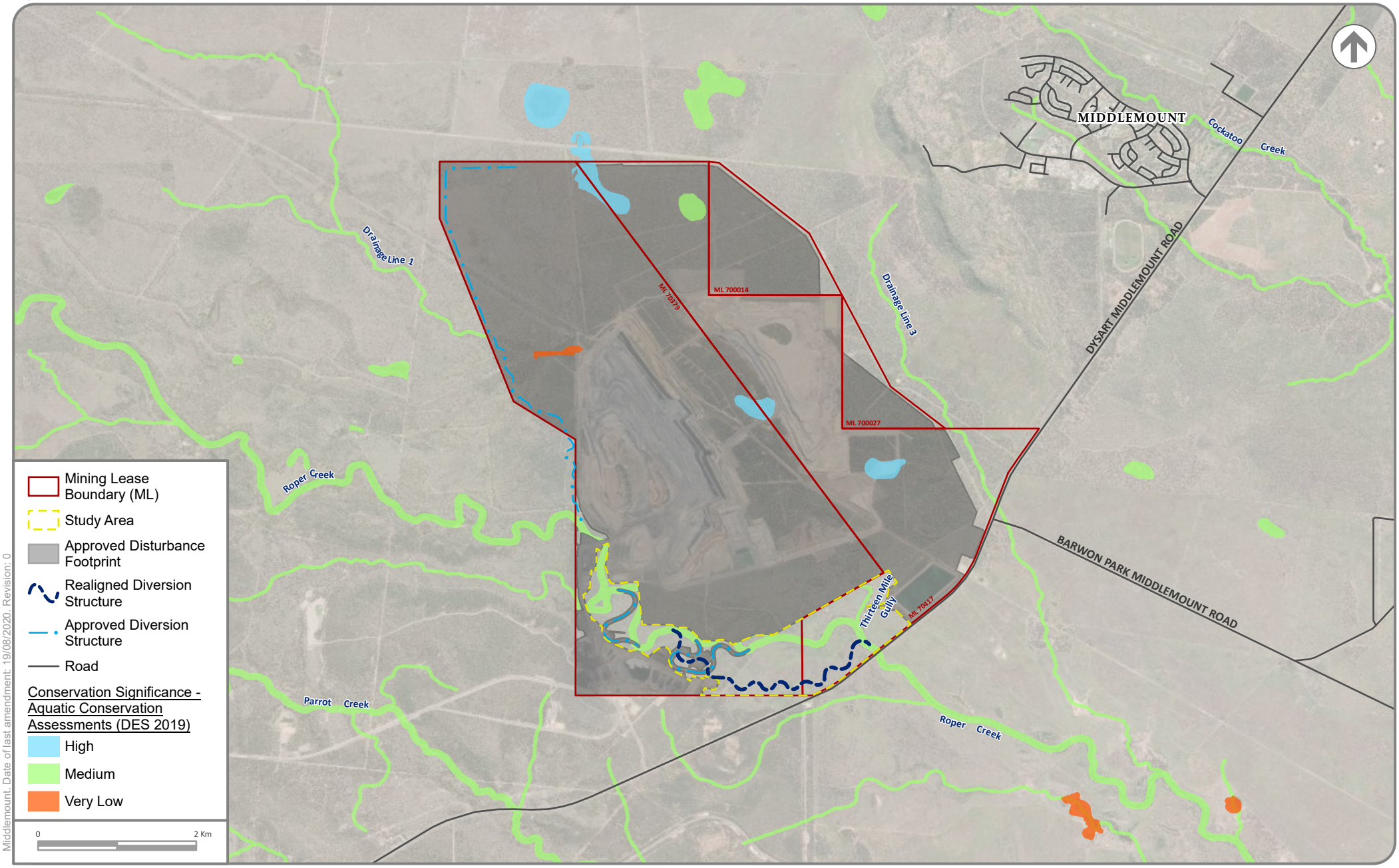
Middlemount. Date of last amendment: 19/08/2020. Revision: 0

DPM ENVIROSCIENCES

WATERCOURSE IDENTIFICATION MAP

Middlemount Coal Mine Southern Extension Project

FIGURE 6



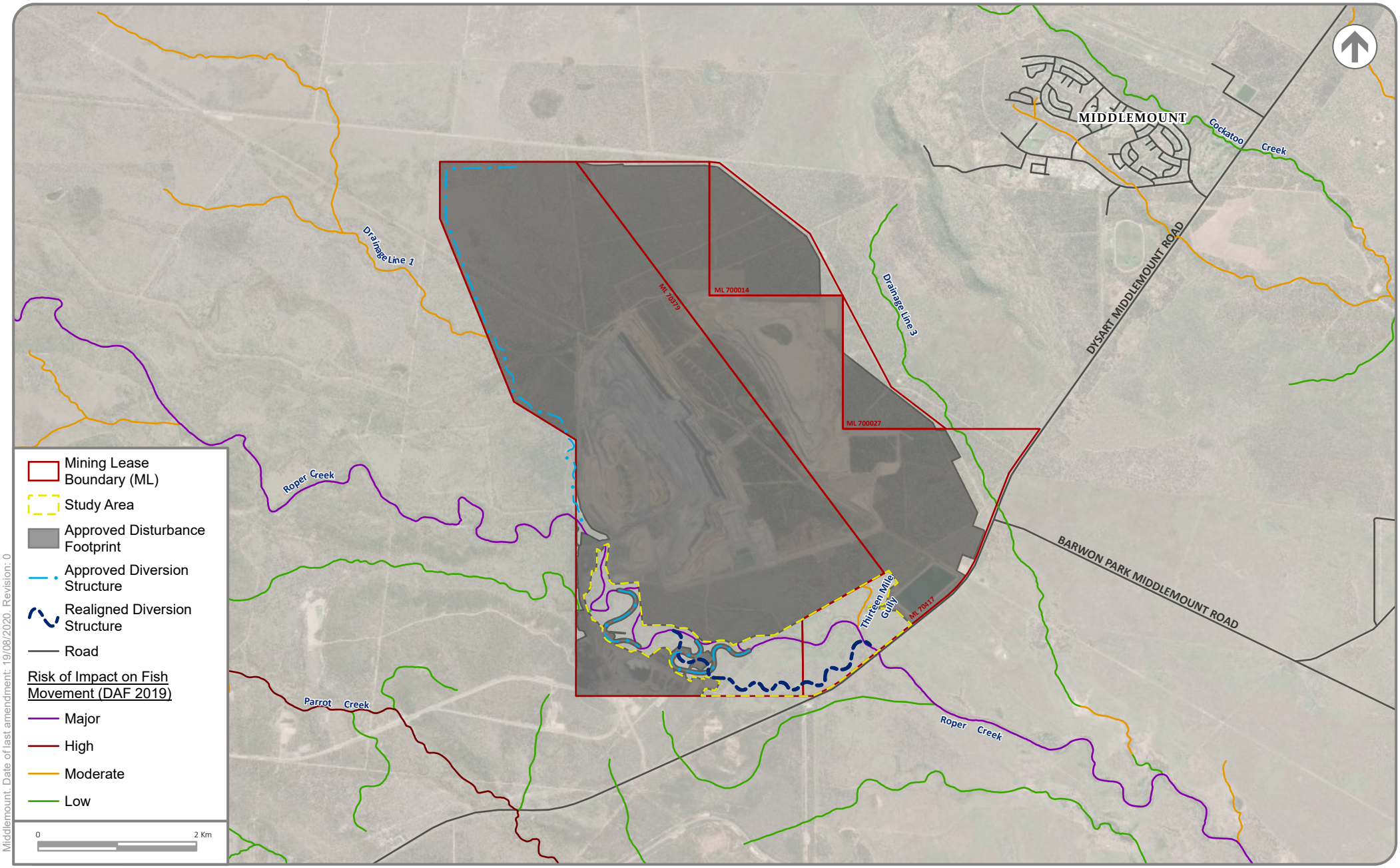
Middlemount. Date of last amendment: 19/08/2020. Revision: 0

DPM ENVIROSCIENCES

AQUATIC CONSERVATION ASSESSMENT MAPPING OF THE STUDY AREA AND SURROUNDS

Middlemount Coal Mine Southern Extension Project

FIGURE 7



Middlemount. Date of last amendment: 19/08/2020. Revision: 0

DPM ENVIROSCIENCES

WATERWAYS FOR WATERWAY BARRIER WORKS

Middlemount Coal Mine Southern Extension Project

FIGURE 8

In consideration of these factors, Roper Creek is mapped as being at 'major risk' of adverse impact from waterway barrier works on fish movement, Thirteen Mile Gully is indicated as being of 'moderate risk' of adverse impact, and the unnamed tributary as being of 'low risk' of adverse impact from waterway barrier works on fish movement (DAF 2019) (Figure 8). Thirteen Mile Gully is now diverted along the western boundary of ML 70379 (Figure 8). Consequently, the downstream reach of Thirteen Mile Gully within the Study area is no longer connective with its natural catchment and now represents a waterway at 'low risk' of adverse impact from waterway barrier works on fish movement.

4.2 Aquatic habitat

4.2.1 Waterways

The waterways of the Study area are ephemeral and expected to experience flow only after sustained or intense rainfall and runoff in the catchment. Stream flows are expected to be highly variable, with pooled water unlikely to remain longer than a few months without follow-up rainfall and runoff in the catchment. As a consequence, physical attributes, water quality, and the composition of aquatic flora and fauna communities are highly variable over time.

4.2.2 Surface water quality

Receiving Environment Monitoring Program

In-situ water quality measurements

Physico-chemical water quality has been monitored at the MCM as part of the Receiving Environment Monitoring Program (REMP) since 2010. Monitoring was undertaken twice-yearly to 2013, then once in 2015, 2016 and 2019. During 2017 and 2018, low rainfall and dry sites prevented monitoring (DPM Envirosciences 2019).

Water quality in Roper Creek is characterised by high and variable turbidity, moderate and variable EC, and low dissolved oxygen (DO) concentrations at times (WRM 2020). Historically (over the 2010 to 2019 period), EC has exceeded the relevant trigger value on several occasions, with the highest values generally observed at upstream sites and spikes occurring in the earlier years of monitoring (DPM Envirosciences 2019). pH has generally been within the recommended range and there has been no consistent pattern between sites upstream and downstream in Roper Creek. DO saturation has varied between sampling events and levels have often been below the lower trigger values. No consistent difference in DO between upstream and downstream sites was found over the 2010 to 2019 period (DPM Envirosciences 2019).

Turbidity has varied dramatically over time at all Roper Creek sites and in the unnamed tributary. On multiple occasions, it has exceeded 1,000 NTU at both upstream and downstream sites, exceeding the relevant Water Quality Objectives (WQOs) (EHP 2011) on most occasions (DPM Envirosciences 2019).

Analytical water quality

Concentrations of metals were generally low in most samples collected from the Roper Creek monitoring locations by GHD during the January / February 2019 monitoring round. Dissolved aluminium and iron exceeded the Release Contaminant Trigger Investigation Levels at all upstream and downstream monitoring locations, and there was one exceedance for dissolved copper at IMPAC2 (GHD 2019) (REMP sites shown on Figure 3).

For most metals with measurable concentrations, some differences were observed between reference, impact and potentially impacted sites. However, dissolved aluminium and iron are the only metals for which concentrations at impact sites appear consistently higher than at references sites (GHD 2019).

Levels of all nutrients were below the relevant trigger level / WQO in the January / February 2019 REMP monitoring, except for total phosphorus, which exceeded the trigger level / WQO at all sites, the highest level being at IMPAC2. Sodium and sulphate concentrations were slightly higher at the downstream sites than at upstream sites (GHD 2019), but remained below the relevant EA triggers.

In-situ water quality

No surface water was encountered at the time of the October 2019 dry season survey. As such, in-situ water quality measurements were not obtained in October 2019. The following paragraphs relate to measurements obtained at the time of sampling in February 2020. Complete results are provided in the site profiles (Appendix C).

Surface water temperatures at the time of assessment ranged from 26.9°C to 30.7°C (Table 8). Water temperatures were likely influenced by time of day, shading and waterbody depth.

pH levels ranged from 7.1 (neutral) to 7.4 (mildly alkaline) (Table 8), reflecting the recent rainfall and runoff and relatively low contact time with substrates. pH levels fell within the WQO guideline range of 6.5-8.5 for moderately disturbed aquatic ecosystems of the Mackenzie Sub-basin (DEHP 2011).

Each wetted site exhibited ‘fresh’ (<800 µS/cm) water, with EC levels ranging from 204 to 290 µS/cm (Table 8). EC levels fell favourably below the WQO guideline of <310 µS/cm for moderately disturbed aquatic ecosystems of the Mackenzie Sub-basin (DEHP 2011).

Surface water DO levels were relatively low across the Study area, ranging from 41.0% to 68.4%, falling below the WQO guideline range of 85-110% for moderately disturbed aquatic ecosystems of the Mackenzie Sub-basin (DEHP 2011) (Table 8). However, exceedances of this guideline range are typical for ephemeral systems. The relatively low DO levels likely reflect a number of factors including time of day, temperature, shading, turbidity (poor light penetration for photosynthetic respiration), organic load, biological activity and rate of transfer from the atmosphere (Appendix B).

Turbidity levels ranged from 390 NTU (poor clarity) to 842 NTU, exceeding the conservative WQO of 50 NTU at each site (Table 8). The turbidity levels reflect a high washload (silts and clays held in suspension) typical of waterways of the region.

Water hardness ranged from 50 mg/L (soft) at site R3 to 74 mg/L (moderate) at site R1 (Table 8), reflecting the recent rainfall and runoff and relatively low contact time with substrates.

Dissolved sulphate levels slightly exceeded the WQO guideline of 10 mg/L at sites R2 (14 mg/L), R3 (12 mg/L), and R4 (15 mg/L), but remained well below the EA receiving waters contaminant trigger level of 250 mg/L.

Table 8 Surface water quality measurements, February 2020

Parameter	Units	WQO	Riverine sites			
		ANZG	R1	R2	R3	R4
Date	DD/MM	-	18/02	19/02	18/02	18/02
Time	00:00	-	7:55	9:35	15:15	11:50
In-situ water quality						
Temperature	°C	-	26.9	27.5	30.7	29.2
pH	pH units	6.5-8.5	7.4	7.3	7.1	7.4
Electrical conductivity	µS/cm (@25C°)	<310^	290	264	204	258
DO	% saturation	85-110*	**51.9**	**47.4**	**41.0**	**68.4**
	mg/L	-	4.1	3.7	3.1	4.8
Turbidity	NTU	50	**390**	**842**	**810**	**398**
Hardness (as $CaCO_3$)#	mg/L	-	74	59	50	68
Total alkalinity (as $CaCO_3$)#	mg/L	-	83	61	55	77
Major cations#						
Calcium (Ca^{2+})	mg/L	-	15	12	10	14
Magnesium (Mg^{2+})	mg/L	-	9	7	6	8
Sodium (Na^{+})	mg/L	-	28	30	27	33
Potassium (K^{+})	mg/L	-	7	6	5	6
Major anions#						
Chloride (Cl^{-})	mg/L	-	24	29	26	31
Sulphate (SO_4^{2-})	mg/L	<10	10	14	12	15
Fluoride (F^{-})	mg/L	-	0.2	0.2	0.2	0.2
Bicarbonate (HCO_3^{-})	mg/L	-	83	61	55	77
Carbonate (CO_3^{2-})	mg/L	-	<1	<1	<1	<1

Notes:

Analysed by the laboratory.

^ Applies to baseflow conditions (as opposed to high flow conditions).

* DO levels for fresh waters only apply to flowing waters. Stagnant pools in intermittent streams naturally experience values of DO below 50% saturation (DEHP 2011).

Major ions

The concentration and proportion of ions in surface waters depends on the location of the waterway (geology, land-use and topography), climate and the proportionate contributions of groundwater flow, interflow and overland flow (Boulton and Brock 1999). 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 may dominate, and during high flows, catchment and atmospheric sources will dominate.

The concentration of major anions and cations in surface water (and groundwater) samples collected from the survey area are provided in Appendix C. The relative proportions of these major cations and anions are presented as a Piper plot in Figure 9 and as a Schoeller diagram in Figure 10, to aid interpretation.

Surface water samples collected from sites R1, R2, R3 and R4 on Roper Creek in February 2020 were fresh, mixed-type waters – slightly dominated by sodium cations, and co-dominated by chloride and bicarbonate anions (Figure 9). Groundwater samples collected from across the site were slightly saline to saline sodium chloride type waters (Figure 9). The Schoeller diagram (Figure 10) further highlights the distinction between surface waters and groundwaters of the Study area.

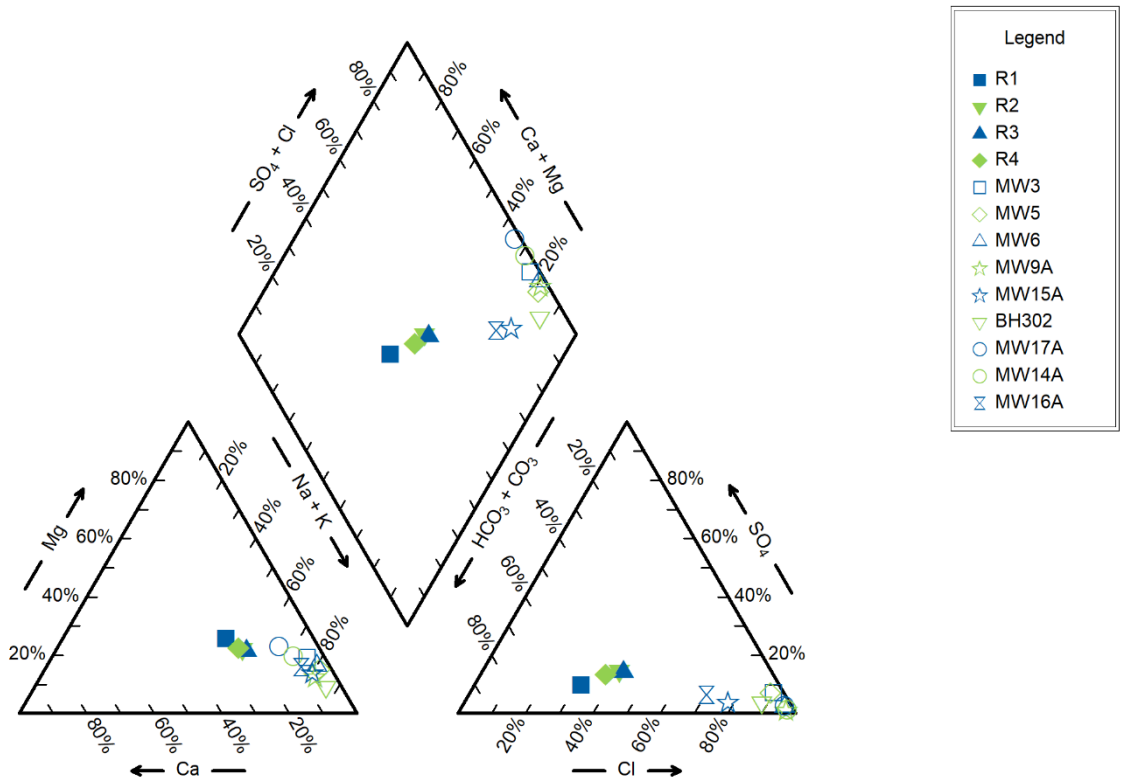


Figure 9 Piper plot showing relative abundance of major cations and anions from surface water and groundwater samples collected from the Study area, February 2020

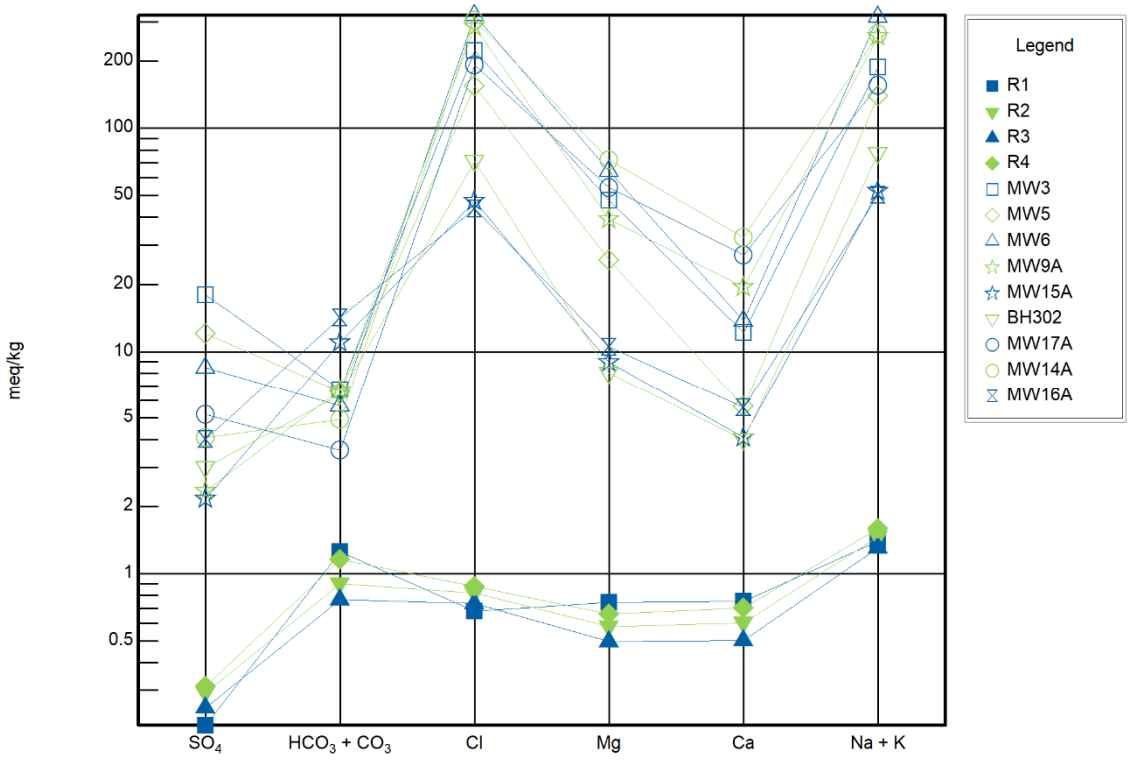


Figure 10 Schoeller diagram showing relative concentrations of major cations and anions from surface water and groundwater samples collected from the Study area, February 2020

Quality assurance / quality control

Sample holding times

The February 2020 samples were received and analysed by ALS Environmental within the recommended sample holding times (Appendix C).

Field blank

Analytical results for the field blank samples (Appendix C) indicate that all analytes were below the LOR, with the exception of low levels of bicarbonate alkalinity close to the LOR. The results confirm that sample handling integrity has been maintained.

Duplicate

Two sets of water samples were collected from site R1 for QA/QC purposes in February 2020. The RPD was calculated for all analytical parameters (Table 9). The RPD scores were within the acceptance criteria (Section 3.5.3) for all parameters, confirming the analytical reliability of the results.

Table 9 Quality assurance / control duplicate water analysis, February 2020

Parameter	Units	LOR	Replicate 1 (R1)	Replicate 2 (DUP)	RPD (%)	Within RPD acceptance
Hardness (as $CaCO_3$)	mg/L	1	74	74	0	✓
Total alkalinity (as $CaCO_3$)	mg/L	1	83	82	1	✓
Bicarbonate alk. (HCO_3^-)	mg/L	1	83	82	1	✓
Calcium (Ca^{2+})	mg/L	1	15	15	0	✓
Magnesium (Mg^{2+})	mg/L	1	9	9	0	✓
Sodium (Na^+)	mg/L	1	28	28	0	✓
Potassium (K^+)	mg/L	1	7	7	0	✓
Chloride (Cl^-)	mg/L	1	24	24	0	✓
Sulphate (SO_4^{2-})	mg/L	1	10	10	0	✓
Fluoride (F^-)	mg/L	0.1	0.2	0.2	0	✓

4.2.3 Instream habitat

Instream (aquatic) habitat assessment scores for the riverine sites within the Study area ranged from 31 (poor) to 56 (fair) in the October 2019 dry season survey, and from 36 to 56 in the February 2020 wet season survey (Table 10).

All four sites on Roper Creek scored poor in October 2019. The site on Thirteen Mile Gully scored fair. Bottom substrate / available cover was rated poor at each site in both seasons, owing to the dominance of fine sediments (sand and silt/clay) and general lack of gravel, pebble, cobble and boulder substrates. However, each site exhibited at least some detritus, sticks, branches and/or logs, providing some instream habitat and refugia for aquatic fauna in times of flow. Embeddedness also rated poor at all sites in both seasons. Velocity / depth category rated poor at each site in October 2019 due to lack of flow, increasing to Fair at sites R1, R2 and R3 in February 2020 owing to the presence of both shallow and deep (>0.5 m) pools. Site R5 on Thirteen Mile Gully scored high for channel alteration and bottom scouring, as it was not subject to the extensive sand and silt deposition observed in Roper Creek. Aquatic habitat assessment scores for Thirteen Mile Gully in October 2019 remained unchanged in February 2020.

Table 10 Aquatic habitat assessment scores for sites across the Study area

Habitat variable	R1	R2	R3	R4	R5
Dry season – October 2019					
Bottom substrate / available cover	P (2)	P (2)	P (2)	P (2)	P (4)
Embeddedness	P (2)	P (1)	P (2)	P (2)	P (1)
Velocity / depth category	P (0)	P (0)	P (0)	P (0)	P (0)
Channel alteration	F (4)	P (2)	P (3)	P (2)	E (12)
Bottom scouring and deposition	P (3)	P (2)	P (2)	P (2)	E (12)
Pool / riffle, run / bend ratio	P (3)	P (2)	P (2)	F (4)	F (4)
Bank stability	G (6)	G (8)	G (8)	G (6)	G (6)
Bank vegetative stability	E (10)	E (9)	E (10)	E (9)	G (8)
Streamside cover	F (4)	F (5)	E (9)	E (9)	E (9)
Total (out of 135)	**34**	**31**	**38**	**36**	**56**
Rating (Section 3.5.2)	**Poor**	**Poor**	**Poor**	**Poor**	**Fair**
Wet season – February 2020					
Bottom substrate / available cover	P (2)	P (2)	P (2)	P (2)	P (4)
Embeddedness	P (2)	P (2)	P (2)	P (2)	P (1)
Velocity / depth category	F (6)	F (6)	F (6)	P (2)	P (0)
Channel alteration	P (3)	P (2)	P (3)	P (2)	E (12)
Bottom scouring and deposition	P (3)	P (2)	P (2)	P (2)	E (12)
Pool / riffle, run / bend ratio	P (3)	P (2)	P (2)	F (4)	F (4)
Bank stability	G (6)	G (6)	G (8)	G (6)	G (6)
Bank vegetative stability	E (10)	E (9)	E (10)	E (10)	G (8)
Streamside cover	F (4)	F (5)	E (9)	E (9)	E (9)
Total (out of 135)	**39**	**36**	**38**	**39**	**56**
Rating (Section 3.5.2)	**Fair**	**Poor**	**Poor**	**Fair**	**Fair**

4.2.4 Bank stability

Bank vegetative stability ranged from good to excellent at each site, indicating that at least 50% of the streambanks were covered by vegetation at the time of assessment. Banks were moderately stable at each site, with only small, infrequent areas of erosion mostly healed over. There remains some potential for erosion in extreme flooding at all sites.

4.2.5 Adjacent land use

Land use across the Study area comprised former cattle grazing country. Riparian zone widths (single bank measurements from the edge of stream bed) ranged from approximately 10 m at site R5 on Thirteen Mile Gully to approximately 35 m at site R2 on Roper Creek. Trees commonly encountered in riparian zones across the Study area included Queensland blue gum (*Eucalyptus tereticornis*), river she-oak (*Casuarina cunninghamiana*), poplar box (*E. populnea*), carbeen (*Corymbia tessellaris*) and sally wattle (*Acacia salicina*). The shrub layer was sparse to very sparse across the site. Groundcover was mid-dense in both October 2019 and February 2020 (Appendix B).

4.2.6 Aquatic values

Aquatic values for each site are presented in the site profiles in Appendix B. Ratings for aquatic values were determined for each site based on the criteria in Section 3.5.9 and are presented in Table 11. The four sites on Roper Creek were rated as having moderate aquatic values, due to the importance of Roper Creek as a regional conduit for fish passage (Section 4.1.1). Site R5 on Thirteen Mile Gully was rated as having low aquatic values.

Table 11 Aquatic values ratings for the Study area

Site	Waterway	Stream order	Key aquatic values / criteria	Aquatic values rating (Section 3.5.9)
R1	Roper Creek	4	▪ Ephemeral stream ▪ Poor to Fair quality instream habitat ▪ No EVNT species or platypus habitat detected ▪ Little cover of Priority flora species ▪ Regional conduit for fish passage	Moderate
R2	Roper Creek	4	▪ Ephemeral stream ▪ Poor quality instream habitat ▪ No EVNT species or platypus habitat detected ▪ Little cover of Priority flora species ▪ Regional conduit for fish passage	Moderate
R3	Roper Creek	4	▪ Ephemeral stream ▪ Poor quality instream habitat ▪ No EVNT species or platypus habitat detected ▪ Little cover of Priority flora species ▪ Regional conduit for fish passage	Moderate
R4	Roper Creek	4	▪ Ephemeral stream ▪ Poor to Fair quality instream habitat ▪ No EVNT species ▪ Little cover of Priority flora species ▪ Regional conduit for fish passage	Moderate
R5	Thirteen Mile Gully	2	▪ Ephemeral stream ▪ Fair quality instream habitat ▪ No EVNT species or platypus habitat detected ▪ Little cover of Priority flora species ▪ Local conduit for fish passage	Low

4.3 Wetlands

4.3.1 Wetlands of International Importance

There are no wetlands of International Importance identified within the Study area or broader search area in the EPBC Act Protected Matters Report (DEE 2020a). Wetlands of International Importance nearest to the Study area include those of the Shoalwater and Corio Bays Area, approximately 160 km east-north-east.

4.3.2 Wetlands of National Importance

No nationally important wetlands occur in the Mackenzie River sub-basin (DES 2020a). The nearest wetland of National Importance is Broad Sound, located approximately 95km east-north-east of the Study area (DEE 2020a).

4.3.3 Referrable wetlands

Wetland Protection Areas

The *Map of Great Barrier Reef Wetland Protection Areas* (DES 2019d) shows the location of Wetland Protection Areas (WPAs), comprising wetlands of High Ecological Significance (HES) and their trigger area buffers. These wetlands have been assessed as containing high ecological values by a bioregional aquatic conservation assessment, the AquaBAMM (Rollason and Howell 2012).

No WPAs are mapped as occurring within the Study area (DES 2019d; Figure 11).

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* (EPP) 2019 . Wetlands are considered either HES or of General Ecological Significance (GES) for the purpose of allocating environmental values. The MQWEV also shows High Ecological Values waters management intent under Schedule 2 of the EPP 2019.

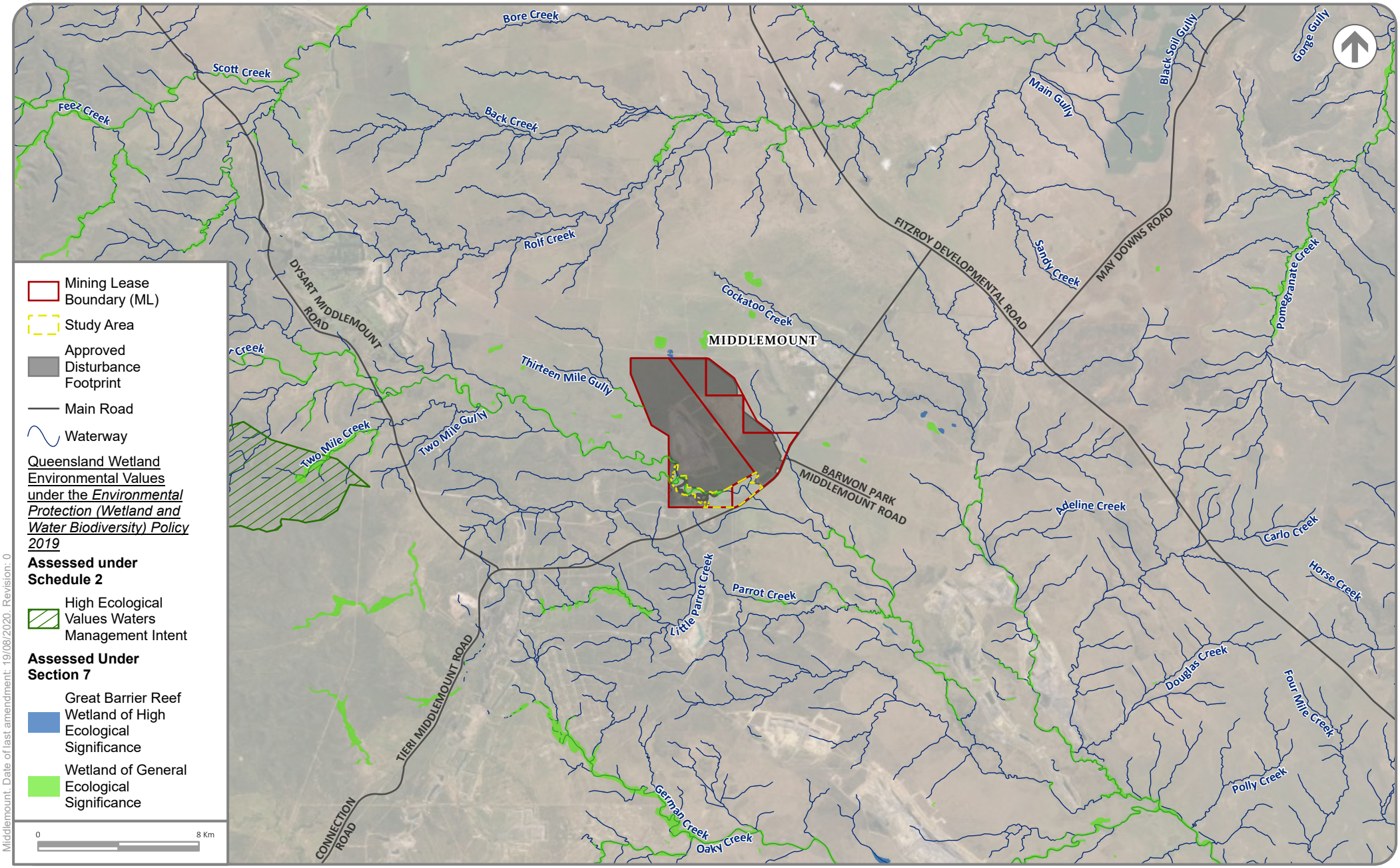
No HES wetlands or High Environmental Value (HEV) waters are mapped as occurring within the Study area (DES 2019e; Figure 11). State-mapped RE 11.3.25 on Roper Creek is mapped as a GES wetland on the MQWEV (DES 2019e; Figure 11).

4.3.4 Other mapped wetlands

The Queensland Wetlands Map (DES 2019b) identifies marine, estuarine, riverine, lacustrine and palustrine waterbodies and wetland REs in Queensland. Within the Study area, this mapping includes:

- riverine wetland RE 11.3.25 on Roper Creek and Thirteen Mile Gully; and
- areas of floodplain RE 11.3.2 and 11.3.7.

No palustrine or lacustrine wetlands or waterbodies are mapped for the Study area (Figure 5). The site visits in October 2019 and February 2020, including on-ground assessment and aerial assessment using a remotely piloted aircraft (drone), found no evidence of floodplain wetlands. Riparian woodland RE 11.3.25 was prevalent along Roper Creek and Thirteen Mile Gully.



Middlemount. Date of last amendment: 19/08/2020. Revision: 0

DPM ENVIROSCIENCES

QUEENSLAND WETLAND ENVIRONMENTAL VALUES

Middlemount Coal Mine Southern Extension Project

FIGURE 11

4.4 Aquatic flora

Only five species of semi-aquatic macrophytes were recorded from the Study area during the October 2019 dry season survey (Table 12), reflecting the harsh physical conditions. More diverse aquatic communities were encountered at each site in the February 2020 wet season survey, with 11 species of semi-aquatic macrophytes recorded.

All aquatic flora species detected are listed as Least Concern under the NC Act. One Priority aquatic floral species was detected, being tall flatsedge (*Cyperus exaltatus*), which was recorded at each site. Tall flatsedge is considered a Priority species in non-riverine wetlands of the GBR catchments due to its tendency to form significant macrophyte beds, providing important habitat and a food source for fauna (Rollason and Howell 2012). Little (1-10%) coverage of tall flatsedge was recorded at each riverine site in the October 2019 and February 2020 surveys, and the species seems to be of little ecological significance.

Table 12 Aquatic flora recorded from the Study area

Scientific name	Common name	Site				
		R1	R2	R3	R4	R5
Dry season survey – October 2019						
Cyperus difformis	Rice sedge			L		
Cyperus exaltatus	Tall flatsedge	L	L	L	L	L
Eclipta prostrata	White eclipta*		L	L	L	
Juncus usitatus	Common rush			L	L	L
Ludwigia octovalvis	Willow primrose		L			
Species richness		**1**	**3**	**4**	**3**	**2**
Wet season survey – February 2020						
Cyperus betchei	-					L
Cyperus difformis	Rice sedge			L		
Cyperus exaltatus	Tall flatsedge	L	L	L	L	L
Cyperus iria	-					L
Cyperus polystachyos	Bunchy sedge		L			
Cyperus victoriensis	-	L	L	S	L	
*Echinochloa colona**	Awnless barnyard grass					L
Eclipta prostrata	White eclipta*	L	L	L	L	
Juncus usitatus	Common rush		L	L	L	L
Leptochloa digitata	Umbrella canegrass					L
Ludwigia octovalvis	Willow primrose		L	L		
Species richness		**3**	**6**	**6**	**4**	**6**

Notes: * denotes introduced species; L = 1-10% (little); S = 10-50% (some); M = 50-75% (moderate); E = >75% (extensive), as per AusRivAS categories (DNRM 2001).

4.5 Aquatic fauna

4.5.1 Fish

No surface water was encountered at the time of the October 2019 dry season survey. Consequently, habitat assessment was undertaken in place of fish survey. Three species were recorded from 320 fishes captured across four locations on Roper Creek during the February 2020 surveys (Table 13). This comprised only juveniles of the Least Concern species: spangled perch (*Leiopotherapon unicolor*) (20-40 mm), eastern rainbowfish (*Melanotaenia splendida splendida*) (15-30 mm) and Hyrtyl's tandan (*Neosilurus hyrtlii*) (30-40 mm), which had likely migrated upstream from downstream dry season refuges following the flow event approximately four weeks prior.

The waterways of the Study area are ephemeral and experience flow only after sustained or intense rainfall and runoff in the catchment. The streambed of Roper Creek is comprised of unconsolidated (loosely arranged and unpacked) sands and silts forming a relatively flat stream bed void of pool or riffle sequences. The transient flow and lack of dry season refuge limits the ability of Roper Creek to provide breeding habitat for native fishes.

Thirteen Mile Gully has a smaller catchment than Roper Creek, although the more consolidated silts and clays of the streambed provide a more natural channel profile, with less deepening or infilling. Following a flow event, wetted habitat is likely to persist in pools located on Thirteen Mile Gully for longer than in Roper Creek.

Roper Creek and Thirteen Mile Gully provide temporary foraging habitat but very limited breeding habitat for common (Least Concern) native fishes adapted to these conditions. Longer periods of rainfall and subsequent flows would likely result in greater fish diversity in the Study area, including other Least Concern species such as gudgeons (*Hypseleotris* spp.), Agassiz's glassfish (*Ambassis agassizii*), fly-specked hardyhead (*Craterocephalus stercusmuscarum*), bony bream (*Nematalosa erebi*) and barred grunter (*Amniataba percoides*), each known from the broader Mackenzie River drainage sub-basin (DES 2020a).

Table 13 Fishes recorded from the Study area, February 2020

Scientific name	Common name	Site				
		R1	R2	R3	R4	R5
Leiopotherapon unicolor	Spangled perch	93	87	99	26	-
Melanotaenia splendida splendida	Eastern rainbowfish	3	-	3	-	-
Neosilurus hyrtlii	Hyrtyl's tandan	3	-	6	-	-
Number of individuals		**99**	**87**	**108**	**26**	**-**
Species richness		**3**	**1**	**3**	**1**	**-**

4.5.2 Freshwater turtles

No surface water was encountered at the time of the October 2019 dry season survey. As such, habitat assessment was undertaken in place of turtle survey. No turtles were recorded during targeted surveys in February 2020.

FRC Environmental (2010) recorded Krefft's river turtle (*Emydura macquarii krefftii*) from two wetland sites approximately 3 km north and north-west of the Study area. The waterways of the Study area may provide transient foraging habitat for Least Concern turtle species such as Krefft's river turtle, broad-shelled river turtle (*Chelodina expansa*) and eastern snake-necked turtle (*C. longicollis*). However, these waterways are unlikely to provide suitable breeding habitat.

No EVNT turtles were detected within the Study area, nor was suitable habitat for EVNT turtles encountered (Section 3.5.5).

4.5.3 Platypus

The platypus (*Ornithorhynchus anatinus*) is listed as Special Least Concern (SLC) for cultural reasons under the NC Act. The Wetland*Info* database identifies the platypus as having previously been recorded from the Mackenzie River drainage sub-basin. However, the seasonal nature of the waterways of the Study area are not conducive to sustaining a population of platypus. No platypus burrows were encountered during the surveys, despite targeted searches. The platypus is considered unlikely to occur within the Study area.

4.5.4 Aquatic invertebrates

Receiving Environment Monitoring Program

Aquatic macroinvertebrate communities have been monitored at the Middlemount Coal Mine as part of the REMP since 2010. Monitoring was undertaken twice-yearly to 2013, then once in 2015, 2016 and 2019 (GHD 2019). During 2017 and 2018, low rainfall and dry sites prevented monitoring (GHD 2019).

The aquatic macroinvertebrate community of sites both upstream and downstream in Roper Creek and the unnamed tributary exhibited signs of stress in January/February 2019, with taxa richness, PET macroinvertebrate richness and Stream Invertebrate Grade Number – Average Level Version 2 (SIGNAL 2) generally below the DEHP (2011) guideline range for Mackenzie River freshwaters (GHD 2019). Given the ephemeral nature of Roper Creek, changes in metrics over time associated with macroinvertebrate communities are to be expected (White et. al. 2017, cited in GHD 2019).

In January/February 2019, there was no clear difference in macroinvertebrate composition or community condition between Roper Creek reference, impact and recovery sites (Figure 2), with no indication of impacts from Middlemount Coal Mine operations on the macroinvertebrate community of Roper Creek in 2019 (GHD 2019).

Historically, there have been some differences in macroinvertebrate metrics between reference and impact sites, although greater variability has been observed between sampling events (GHD 2019). In most cases, the temporal trend was similar between reference and impact sites, suggesting that the macroinvertebrate community responds to environmental conditions such as rainfall and temperature (GHD 2019). Macroinvertebrate metrics at both reference and impact sites have frequently been observed to be below the guideline range for Mackenzie River freshwaters, which is to be expected in this water and habitat limited system (GHD 2019).

Aquatic macroinvertebrates and stream health

No surface water was encountered at the time of the October 2019 dry season survey. As such, aquatic macroinvertebrate sampling was not undertaken in October 2019.

A total of 34 aquatic macroinvertebrate taxa were identified from 618 specimens collected from four sites on Roper Creek in February 2020. Raw macroinvertebrate data are presented in Appendix D.

Taxonomic composition

The most taxa-rich orders of aquatic macroinvertebrates collected from the Study area were Coleoptera (beetles) and Hemiptera (true bugs), each with six families identified. Diptera (true flies) was also well represented, with five families identified. Other taxa included Ephemeroptera (mayflies), Trichoptera (caddis flies), Zygoptera (damselflies), Epiprocta (dragonflies), Acarina (mites), Decapoda (yabbies, crabs and river prawns), Gastropoda (snails), Cladocera (water fleas), Copepoda (copepods) and Ostracoda (seed shrimp).

Aquatic macroinvertebrate taxa richness ranged from 8 to 16 taxa in samples collected from bed habitats, and from 16 to 24 taxa in samples collected from edge habitats (Figure 12). Data is presented alongside the DEHP WQOs for moderately disturbed aquatic ecosystems of the 'Mackenzie River Sub-basin waters' (DEHP 2011).

Taxa richness was greater in the edge habitat of each site than in the bed habitat, likely owing to the greater habitat complexity and food sources. Taxa richness in the bed habitat samples collected from sites R1 and R2 and in the edge habitat sample collected from site R1 fell within the DEHP (2011) 20:80 percentile guideline range (Figure 12). Taxa richness in all other samples fell below the DEHP (2011) 20:80 percentile guideline range (Figure 12).

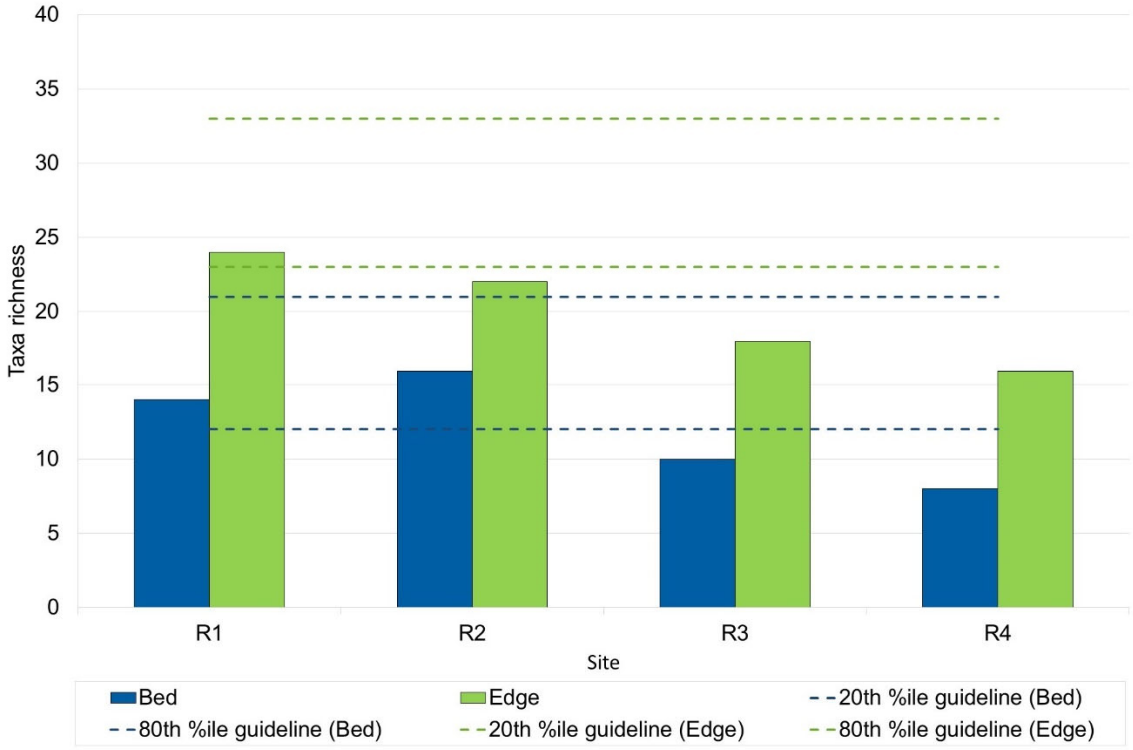


Figure 12 Taxa richness of aquatic macroinvertebrate samples collected from the Study area, February 2020

PET taxa

Three PET taxa were recorded in samples collected from the Study area, including Ephemeroptera (mayfly) families (Baetidae and Caenidae) and one Trichoptera (caddisfly) family (Leptoceridae). No Plecoptera (stoneflies) families were recorded, nor are they expected to occur due to lack of suitable habitat.

PET taxa richness ranged from 0 to 2 taxa in both the bed and edge samples (Figure 13). Data is presented alongside the DEHP WQOs for moderately disturbed aquatic ecosystems of the 'Mackenzie River Sub-basin waters' (DEHP 2011).

PET taxa richness in the bed habitat samples collected from sites R1 and R2 and in the edge habitat sample collected from site R2 aligned with the DEHP (2011) 20:80 percentile guideline range, indicating an expected number of pollutant sensitive taxa. PET taxa richness in all other samples fell below the guideline range.

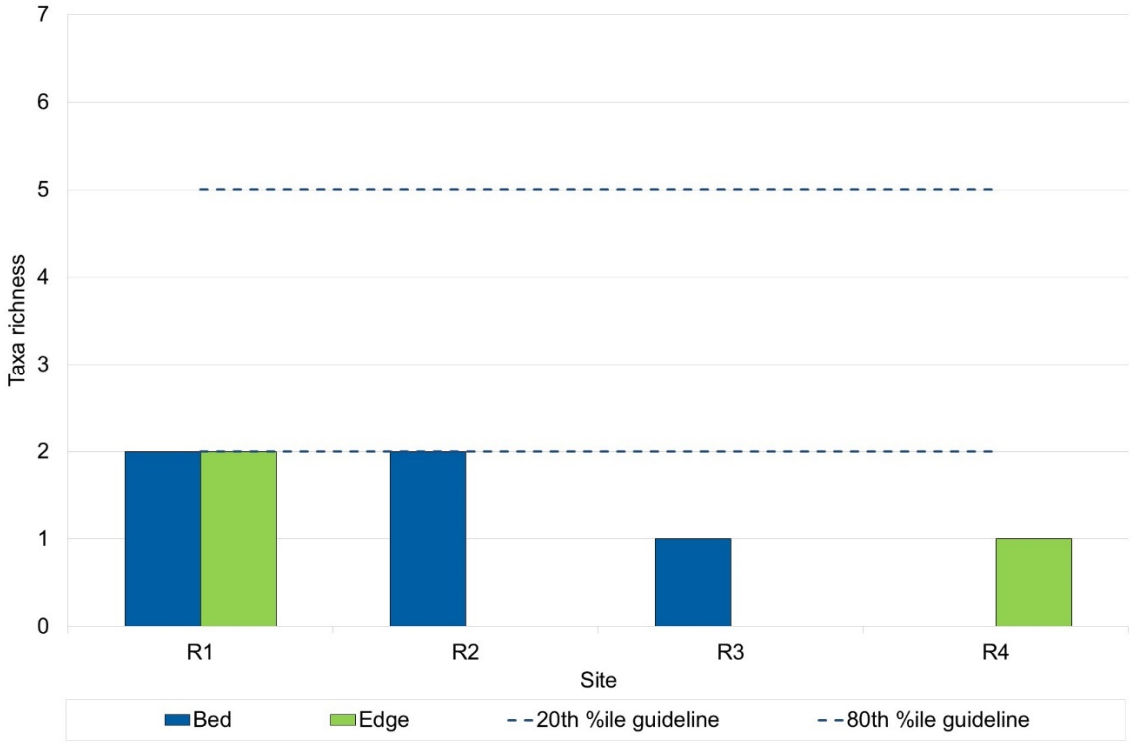


Figure 13 PET taxa richness of aquatic macroinvertebrate samples collected from the Study area, February 2020

Pollution-tolerant taxa

The percentage of pollution-tolerant taxa (SIGNAL 2 score of 1-3) ranged from 45% to 80% in the bed habitat samples and from 47% to 57% in the edge habitat samples (Figure 12). Data is presented alongside the DEHP WQOs for moderately disturbed aquatic ecosystems of the 'Mackenzie River Sub-basin waters' (DEHP 2011).

The percentage of pollution tolerant taxa in the bed habitat samples collected from site R1 and the edge habitat samples collected from sites R1 and R3 fell favourably within the DEHP (2011) 20:80 percentile guideline range. All other samples exceeded the DEHP (2011) 20:80 percentile guideline range, indicating unfavourable physical conditions and / or reduced habitat quality.

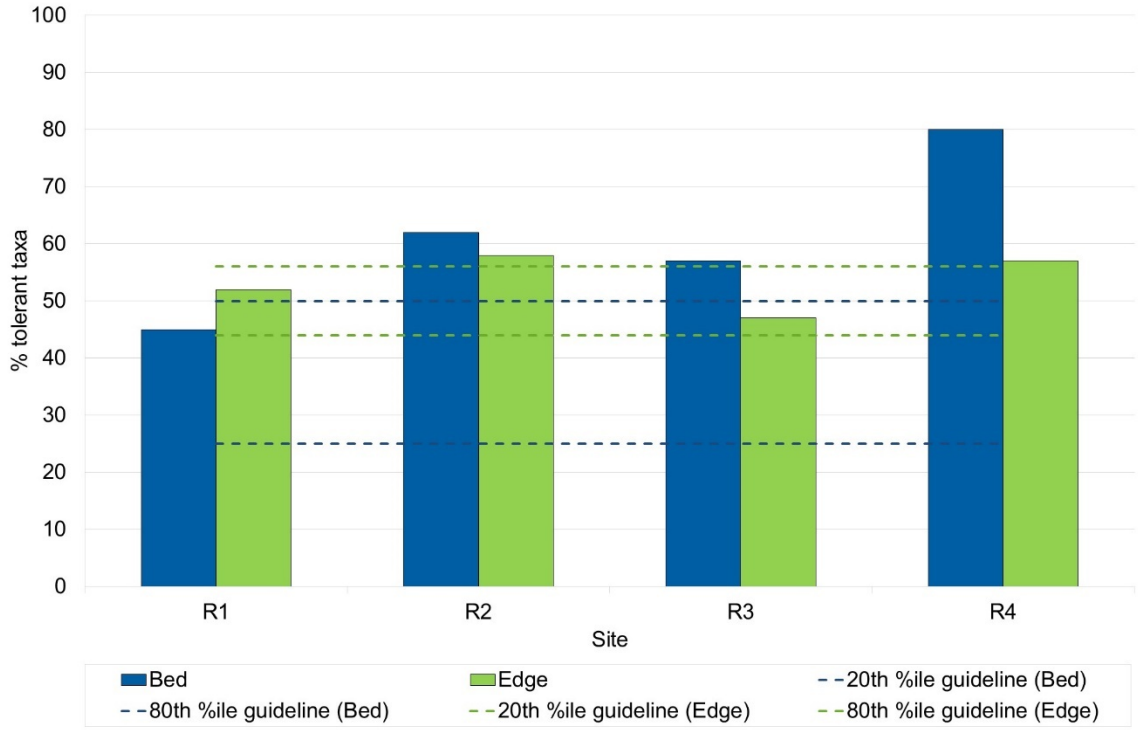


Figure 14 Percentage of pollution-tolerant taxa in aquatic macroinvertebrate samples collected from the Study area, February 2020

SIGNAL 2 scores

Average SIGNAL2 scores ranged from 2.60 to 3.55 for samples collected from bed habitats and from 3.14 to 3.53 for samples collected from edge habitats (Figure 15). SIGNAL2 results are presented against the DEHP WQOs for moderately disturbed aquatic ecosystems of the 'Mackenzie River Sub-basin waters' (DEHP 2011).

The SIGNAL2 scores for the bed habitat sample collected from site R1 and the edge habitat samples collected from sites R2 and R3 fell within the DEHP (2011) 20:80 percentile guideline range, reflecting the expected composition of pollution sensitive taxa. SIGNAL 2 scores for the bed habitat samples collected from sites R2, R3 and R4, and the edge habitat samples collected from sites R1 and R4 fell below the DEHP (2011) 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 moderately disturbed aquatic ecosystems in the Mackenzie Sub-basin waters.

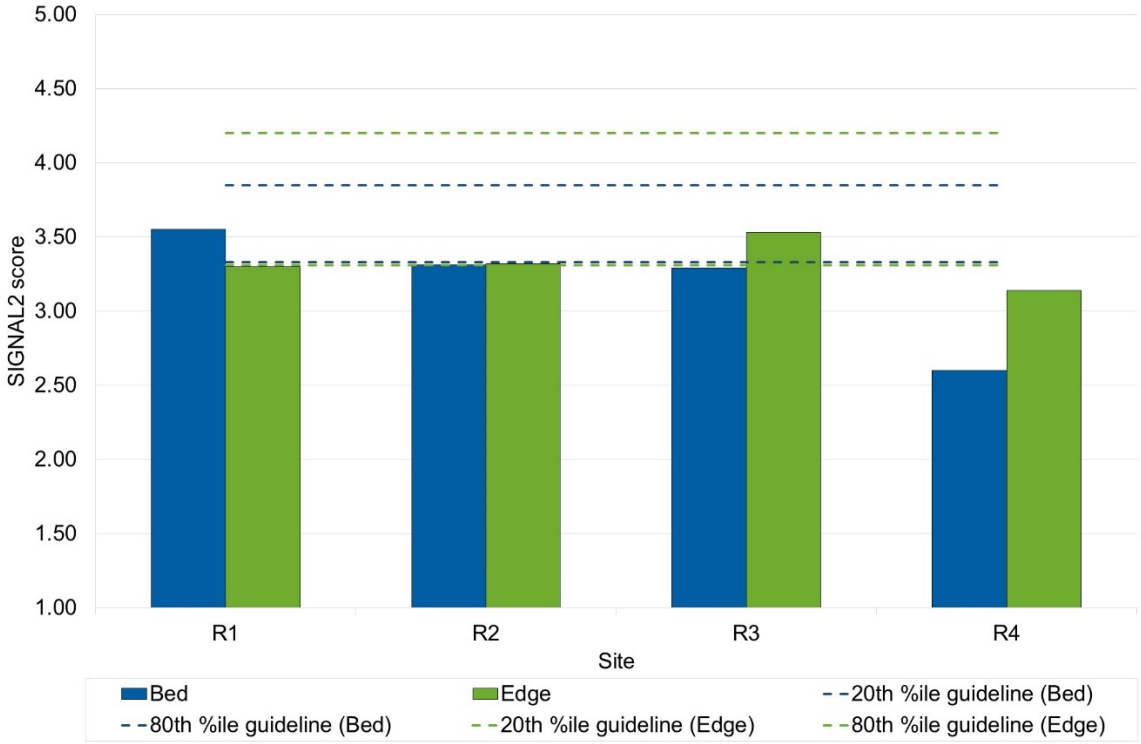


Figure 15 SIGNAL2 scores for aquatic macroinvertebrate samples collected from the Study area, February 2020

Macro-crustaceans

Three macro-crustacean families were encountered within the Study area, including Gercarcinucidae (inland freshwater crab *Austrothelphusa transversa* [Plate 1]), Palaemonidae (freshwater prawn *Macrobrachium australiense*) and Parasticidae (yabby *Cherax* sp. [Plate 1]).

Inland freshwater crab (*Austrothelphusa transversa*)

Yabby (*Cherax* sp.)

Plate 1 Macro-crustaceans captured and identified from the Study area, February 2020

4.7 Conservation significant species

4.7.1 Aquatic flora

No aquatic flora species listed under the EPBC Act and/or NC Act were recorded during the surveys. The Wetland*Info* database identifies five EVNT species that have previously been recorded from the broader Fitzroy Basin (DES 2020a), none of which are likely to occur within the Study area (Table 14).

4.7.2 Fishes

The Wetland*Info* database identifies 53 fish species that have previously been recorded from the Fitzroy Basin (DES 2020a). Of these, two are listed as EVNT:

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

Due to habitat requirements and distributional range, it is highly unlikely these EVNT species occur within waterbodies of the Study area as either resident or transient occurrences.

An additional EVNT fish species, the Vulnerable (EPBC Act and NC Act) honey blue-eye (*Pseudomugil mellis*), is identified in the ACA Expert Panel Report for non-riverine wetlands in the Fitzroy section of the GBR catchment (Rollason and Howell 2012). However, this species is not listed by Wetland*Info* as having been recorded from the Fitzroy Basin (DES 2020a) and is also unlikely to occur in the Study area.

The BoT Actions for Biodiversity for the Fitzroy NRM region (DERM 2010) report lists the ornate rainbowfish (*Rhadinocentrus ornatus*) as a Priority species (Table 15). An additional 11 Priority fish species are recorded by the ACA Expert Panel Reports for the Fitzroy section of the GBR catchment (Inglis and Howell 2009; Rollason and Howell 2012) (Table 15). No Priority fish species are likely to occur within the Study area based on consideration of their habitat requirements and distribution (Table 15).

4.7.3 Freshwater turtles

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 EVNT:

- 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 also identified in the EPBC Act Protected Matters Report for the search area (DEE 2020a). There are no Priority turtle species identified in the BoT Actions for Biodiversity for the Fitzroy NRM region (DERM 2010) or ACA Expert Panel Reports for the Fitzroy section of the GBR catchment (Inglis and Howell 2009; Rollason and Howell 2012) that aren't also listed under the EPBC Act or NC Act (Table 16).

Due to habitat requirements and distributional range, it is unlikely that these EVNT turtle species occur within waterbodies of the Study area as either resident or transient occurrences (Table 16).

4.7.4 Freshwater invertebrates

No aquatic invertebrates are identified in the EPBC Act Protected Matters Report, nor in the BoT Actions for Biodiversity for the Fitzroy NRM region (DERM 2010).

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.

The ACA Expert Panel Report (riverine wetlands) for the Fitzroy sub-catchment of the GBR catchment (Rollason and Howell 2012) lists two Priority aquatic invertebrates: the spiny crayfish (*Euastacus monteithorum*) and the Eungella spiny crayfish (*E. eungella*). Due to their distributional range and high altitude requirements, it is unlikely these species occur in the Study area (Table 17).

Table 14 EVNT and Priority aquatic flora recorded from the desktop searches

Scientific name	Common name	Status				Preferred habitat	Likelihood of occurrence within Study area based on desktop	Likelihood of occurrence within Study area post field survey	Data Source				
		EPBC Act[1]	NC Act[2]	Back on Track[3]	ACA[4]				Inglis and Howell 2009	Rollason and Howell 2012	DEE 2020a	DERM 2010	DES 2020a
EVNT species													
Eriocaulon carsonii (including subsp. *orientale*)	salt pipewort / button grass	E	E	H/H		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. Preferred habitat is not present within the Study area.	**Unlikely**. 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 distribution (ALA 2020) is not in proximity to the Study area. Preferred habitat is not present within the Study area.	**Unlikely**. Not detected during field surveys.					✓

Scientific name	Common name	Status				Preferred habitat	Likelihood of occurrence within Study area based on desktop	Likelihood of occurrence within Study area post field survey	Data Source				
		EPBC Act[1]	NC Act[2]	Back on Track[3]	ACA[4]				Inglis and Howell 2009	Rollason and Howell 2012	DEE 2020a	DERM 2010	DES 2020a
Myriophyllum artesium	-		E	H/H	R & T	Wetlands and creek lines associated with springs emanating from the Great Artesian Basin and associated basins (DES 2020b).	**Unlikely**. Current known distribution (ALA 2020) is not in proximity to the Study area. Spring fed wetlands and creeks not known to occur within the Study area. Preferred habitat is not present within the Study area.	**Unlikely**. Not detected during field surveys.		✓		✓	✓
Phaius australis	lesser swamp-orchid	E	E	C/C	R & T	Grows in sandy areas where soils are almost always damp, but not flooded for lengthy periods; occurring in southern Queensland and northern NSW (DES 2020c).	**Unlikely**. Current known distribution (ALA 2020) is not in proximity to the Study area. Preferred habitat is not present within the Study area.	**Unlikely**. Not detected during field surveys.		✓	✓	✓	✓
Thelypteris confluens	swamp fern		V		R & T	Found in permanently swampy areas and mound springs (DES 2020d). Occurs in the Queensland pastoral districts on	**Unlikely**. Current known distribution (ALA 2020) is not in proximity to the Study area. Preferred habitat is not present within the Study	**Unlikely**. Not detected during field surveys.		✓			✓

Scientific name	Common name	Status				Preferred habitat	Likelihood of occurrence within Study area based on desktop	Likelihood of occurrence within Study area post field survey	Data Source				
		EPBC Act[1]	NC Act[2]	Back on Track[3]	ACA[4]				Inglis and Howell 2009	Rollason and Howell 2012	DEE 2020a	DERM 2010	DES 2020a
						Leichhardt, Moreton and Wide Bay (DES 2020d).	area.						
Priority species													
Aponogeton queenslandicus	-				R & T	Temporary freshwater non-riverine waterbodies on clay substrates in drier regions (DES 2020e).	**Unlikely**. The species habitat may occur in the Study area; however, there are no records within 50 km of the Study area.	**Unlikely**. Not detected during field surveys.		✓			✓
Baumea articulata	jointed twigrush		L		P	Grows in standing water <1 m deep. Inhabits coastal lagoons, deeper swamps and slow-moving streams. Scattered occurrence in inland wetlands (Fielder et al. 2011).	**Unlikely**. Preferred habitat does not occur within the Study area.	**Unlikely**. Not detected during field surveys.		✓			✓

Scientific name	Common name	Status				Preferred habitat	Likelihood of occurrence within Study area based on desktop	Likelihood of occurrence within Study area post field survey	Data Source				
		EPBC Act[1]	NC Act[2]	Back on Track[3]	ACA[4]				Inglis and Howell 2009	Rollason and Howell 2012	DEE 2020a	DERM 2010	DES 2020a
Baumea rubiginosa	soft twigrush		L		P	Grows in damp environments such as ephemeral swamps, lagoons and creek banks (Sainty and Jacobs 2003).	**Unlikely**. The species habitat may occur in the Study area; however, there are no records within 50 km of the Study area.	**Unlikely**. Not detected during field surveys.		✓			✓
Cyperus exaltatus	tall flatsedge		L		P	Forms extensive stands along inland rivers and creeks, in areas which are often flooded. Grows in swamps and wetland margins (Sainty and Jacobs 2003).	**Potential**. The species habitat is known to occur in the broader search area and there are records within 50 km of the Study area.	**Known**. Detected at each site.		✓			✓
Eleocharis blakeana	-		L	H/M	R	Occurs on plains and low undulating country on poorly drained, clayey soils; commonly in ephemeral wet habitats in gilgai country and in small depressions along drainage lines in open forest and woodland	**Potential**. The species habitat is known to occur in the broader search area and there are records within 50 km of the Study area.	**Unlikely**. Not detected during field surveys.	✓			✓	✓

Scientific name	Common name	Status				Preferred habitat	Likelihood of occurrence within Study area based on desktop	Likelihood of occurrence within Study area post field survey	Data Source				
		EPBC Act[1]	NC Act[2]	Back on Track[3]	ACA[4]				Inglis and Howell 2009	Rollason and Howell 2012	DEE 2020a	DERM 2010	DES 2020a
						communities (Halford 1996; and Wilson 2006, cited in DES 2020f).							
Eleocharis dulcis	water chestnut		L		P	Grows in shallow lagoons and floodplains, on heavy soils (Sainty and Jacobs 2003).	**Unlikely**. The species habitat may occur in the Study area; however, there are records within 50 km of the Study area.	**Unlikely**. Not detected during field surveys.		✓			✓
Eleocharis sphacelata	tall spikerush		L		P	Grows in stationary or slow-moving water bodies of the coast and inland; occurring in shallow water up to 2m depth (Sainty and Jacobs 2003).	**Unlikely**. Preferred habitat does not occur within the Study area.	**Unlikely**. Not detected during field surveys.		✓			✓
Gahnia sieberiana	sword grass		L		P	Swamps and wet heaths (Melzer and Plumb 2011).	**Unlikely**. The species habitat may occur in the Study area; however, there are records within 50 km of the Study area.	**Unlikely**. Not detected during field surveys.		✓			✓

Scientific name	Common name	Status				Preferred habitat	Likelihood of occurrence within Study area based on desktop	Likelihood of occurrence within Study area post field survey	Data Source				
		EPBC Act[1]	NC Act[2]	Back on Track[3]	ACA[4]				Inglis and Howell 2009	Rollason and Howell 2012	DEE 2020a	DERM 2010	DES 2020a
Leersia hexandra	swamp rice grass		L		P	Edges of billabongs, in swamps and constructed wetlands. Forms dense stands, often excluding other plant species (Sainty and Jacobs 2003).	**Unlikely**. The species habitat may occur in the Study area; however, there are records within 50 km of the Study area.	**Unlikely**. Not detected during field surveys.		✓			✓
Monochoria cyanea	monochoria		L		P	Generally rooted in the mud; preferring stationary or slow-flowing nutrient-rich water, but will survive for short periods on drying mud (Sainty and Jacobs 2003).	**Potential**. The species habitat may occur in the broader search area and there are records within 50 km of the Study area.	**Unlikely**. Not detected during field surveys.		✓			✓
Myriophyllum simulans	-		L		P	Grows in still water, or more frequently, fully emergent on mud (Harden 2002).	**Unlikely**. The species habitat may occur in the Study area; however, there are records within 50 km of the Study area.	**Unlikely**. Not detected during field surveys.	✓				✓
Myriophyllum verrucosum	water milfoil		L		P	Various habitats, from deep water to exposed	**Unlikely**. The species habitat may occur in the	**Unlikely**. Not detected during field	✓				✓

Scientific name	Common name	Status				Preferred habitat	Likelihood of occurrence within Study area based on desktop	Likelihood of occurrence within Study area post field survey	Data Source				
		EPBC Act[1]	NC Act[2]	Back on Track[3]	ACA[4]				Inglis and Howell 2009	Rollason and Howell 2012	DEE 2020a	DERM 2010	DES 2020a
						mud (Harden 2002).	Study area; however, there are records within 50 km of the Study area.	surveys.					
Najas tenuifolia	water nymph		L		P	Fresh water less than 3 m deep, widespread; submerged aquatic species (Fielder et al. 2011).	**Unlikely**. The species habitat may occur in the Study area; however, there are records within 50 km of the Study area.	**Unlikely**. Not detected during field surveys.	✓	✓			✓
Nelumbo nucifera	pink waterlily		L		P	Deep lagoons and deep slow-moving streams (Fielder et al. 2011).	**Unlikely**. Preferred habitat does not occur within Study area.	**Unlikely**. Not detected during field surveys.	✓	✓			✓
Nymphaea gigantea	giant waterlily		L		P	Permanent deep water with muddy substrates (Sainty and Jacobs 2003).	**Unlikely**. The species habitat may occur in the Study area; however, there are records within 50 km of the Study area.	**Unlikely**. Not detected during field surveys.	✓	✓			✓
Nymphoides exiliflora	-		L		P	Saturated soils or clear shallow (to 5cm) fresh water; low heath and edge swamps on sandy soils (Stanley and Ross 1983).	**Unlikely**. Preferred habitat does not occur within Study area.	**Unlikely**. Not detected during field surveys.	✓	✓			✓

Scientific name	Common name	Status				Preferred habitat	Likelihood of occurrence within Study area based on desktop	Likelihood of occurrence within Study area post field survey	Data Source				
		EPBC Act[1]	NC Act[2]	Back on Track[3]	ACA[4]				Inglis and Howell 2009	Rollason and Howell 2012	DEE 2020a	DERM 2010	DES 2020a
Nymphoides indica	water snowflake		L		P	Stationary and slow-moving water bodies (Sainty and Jacobs 2003).	**Unlikely**. Preferred habitat does not occur within Study area.	**Unlikely**. Not detected during field surveys.	✓	✓			✓
Ottelia alismoides	-		L		P	Margins of lakes, ponds and backwaters; usually submerged, but may be partly emergent in shallow water (Sainty and Jacobs 2003).	**Unlikely**. The species habitat may occur in the Study area; however, there are records within 50 km of the Study area.	**Unlikely**. Not detected during field surveys.	✓	✓			✓
Paspalum distichum	water couch		L		P	Damp areas and margins of waterbodies, creeks, streams, channels and drains on the coast and inland (Sainty and Jacobs 2003).	**Unlikely**. The species habitat may occur in the Study area; however, there are records within 50 km of the Study area.	**Unlikely**. Not detected during field surveys.	✓	✓			✓
Phragmites australis	common reed		L		P	Stationary or slow-moving waterbodies, margins of creeks, streams, channels and drains, swamps, areas with high water or that are seasonally inundated;	**Unlikely**. The species habitat may occur in the Study area; however, there are records within 50 km of the Study area.	**Unlikely**. Not detected during field surveys.	✓	✓			✓

Scientific name	Common name	Status				Preferred habitat	Likelihood of occurrence within Study area based on desktop	Likelihood of occurrence within Study area post field survey	Data Source				
		EPBC Act[1]	NC Act[2]	Back on Track[3]	ACA[4]				Inglis and Howell 2009	Rollason and Howell 2012	DEE 2020a	DERM 2010	DES 2020a
						tolerant of slightly brackish water (Sainty and Jacobs 2003). May grow in deep and permanent waters, or shallow, seasonally inundated lowlands, or where there is a permanently high watertable not far below the surface (Romanowski 1998).							
Schoenoplectus mucronatus	schoenoplectus		L		P	Creek and river banks, periodically inundated floodplains and in billabongs. Banks of stationary or slow-moving waterbodies and floodplains (Sainty and Jacobs 2003).	**Unlikely**. The species habitat may occur in the Study area; however, there are records within 50 km of the Study area.	**Unlikely**. Not detected during field surveys.		✓			✓

Scientific name	Common name	Status				Preferred habitat	Likelihood of occurrence within Study area based on desktop	Likelihood of occurrence within Study area post field survey	Data Source				
		EPBC Act[1]	NC Act[2]	Back on Track[3]	ACA[4]				Inglis and Howell 2009	Rollason and Howell 2012	DEE 2020a	DERM 2010	DES 2020a
Typha orientalis	broad-leaved cumbungi		L		P	Stationary or slow-moving waterbodies, margins of creeks and rivers of the inland and coast; fresh or brackish water up to 2 m deep (Sainty and Jacobs 2003).	**Unlikely**. The species habitat may occur in the Study area; however, there are records within 50 km of the Study area.	**Unlikely**. Not detected during field surveys.	✓	✓			✓
Vallisneria nana	ribbonweed		L		P	Still to fast-flowing waters of streams, lakes, ponds and irrigation channels (Stephens and Dowling 2002).	**Unlikely**. The species habitat may occur in the Study area; however, there are records within 50 km of the Study area.	**Unlikely**. Not detected during field surveys.	✓	✓			✓

Notes:

E = Endangered, V = Vulnerable, L = Least Concern, C = Critical Priority, H = High Priority, M = Medium Priority, P = Priority, R&T = Rare and Threatened.

1. EPBC Act = status under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*.
2. NC Act = status under the Queensland *Nature Conservation Act 1992*.
3. Back on Track = status under the DERM (2010) Fitzroy Natural Resource Management Region – Back on Track Actions for Biodiversity.
4. ACA = status under the Aquatic Conservation Assessments using AquaBAMM for riverine and non-riverine wetlands of the Great Barrier Reef catchments (Inglis and Howell 2009; Rollason and Howell 2012).

* *Aponogeton queenslandicus* is listed as Rare in the ACA for the riverine wetlands of the Great Barrier Reef catchment: Fitzroy region. However, as of May 2010, this species is a Least Concern species under the NC Act.

References:

- Inglis and Howell 2009, Aquatic Conservation Assessments using AquaBAMM for the riverine wetlands of the Great Barrier Reef catchment: Fitzroy region.
- Rollason and Howell 2012, Aquatic Conservation Assessments using AquaBAMM for the non-riverine wetlands of the Great Barrier Reef catchment: Fitzroy region
- Commonwealth Department of the Environment and Energy (DEE) 2019, EPBC Act Protected Matters Report – created 26/09/2019.
- Queensland Department of Environment and Resource Management (DERM) 2010, Fitzroy Natural Resource Management Region – Back on Track Actions for Biodiversity.
- Queensland Department of Environment and Science (DES) 2020a, Wetland*Info* – Fitzroy Basin – Wetland Summary Information.

Table 15 EVNT and Priority fish species recorded from the desktop search area

Scientific name	Common name	Status				Preferred habitat	Likelihood of occurrence within Study area based on desktop	Likelihood of occurrence within Study area post field survey	Data Source				
		EPBC Act[1]	NC Act[2]	Back on Track[3]	ACA[4]				Inglis and Howell 2009	Rollason and Howell 2012	DEE 2020a	DERM 2010	DES 2020a
EVNT species													
Pseudomugil mellis	Honey blue-eye	V	V		R&T	Found in coastal lowland wallum, inhabiting flowing and still waterbodies. Generally found in areas with little or no flow, and where emergent and submerged aquatic plants are abundant (Pusey et al. 2004).	**Unlikely**. Outside of natural area of distribution (ALA 2020). Preferred habitat does not occur within the Study area.	**Unlikely**. Species or species habitat not detected during field surveys.		✓			
Priority species													
Hephaestus fuliginosus	Sooty grunter		LC		✓	Found across a range of stream types from small tributaries to large lowland rivers, preferring flowing water of moderate depth, with juveniles most abundant in riffles and runs. Structural woody habitat, submerged root masses and bank	**Unlikely**. Not previously recorded from the Mackenzie River drainage sub-basin (DES 2020a). Natural distribution is outside of the Study area, although species has been translocated into an area encompassing the Study area. Preferred habitat	**Unlikely**. Species or species habitat not detected during field surveys.	✓	✓			✓

Scientific name	Common name	Status				Preferred habitat	Likelihood of occurrence within Study area based on desktop	Likelihood of occurrence within Study area post field survey	Data Source				
		EPBC Act[1]	NC Act[2]	Back on Track[3]	ACA[4]				Inglis and Howell 2009	Rollason and Howell 2012	DEE 2020a	DERM 2010	DES 2020a
						undercuts are important habitat features (Pusey et al. 2004). Translocated populations in Fitzroy catchment are widely distributed (Pusey et al. 2004).	does not occur within the Study area.						
Kuhlia rupestris	Jungle perch		LC		✓	Patchily distributed in fast-flowing streams and rivers; however, also known to occur within floodplain lagoons. Usually occurs in coastal rainforest drainages from the tip of the Cape York Peninsula south to Fraser Island (Allen et al. 2002).	**Unlikely**. Outside of natural area of distribution (ALA 2020). Preferred habitat does not occur within the Study area.	**Unlikely**. Species or species habitat not detected during field surveys.	✓				
Lates calcarifer	Barramundi		LC		✓	Young live in freshwater upper reaches of rivers, favouring undercut banks, submerged logs and overhanging vegetation.	**Unlikely**. Outside of natural area of distribution (ALA 2020). Preferred habitat does not occur within the Study area.	**Unlikely**. Species or species habitat not detected during field surveys.	✓	✓			✓

Scientific name	Common name	Status				Preferred habitat	Likelihood of occurrence within Study area based on desktop	Likelihood of occurrence within Study area post field survey	Data Source				
		EPBC Act[1]	NC Act[2]	Back on Track[3]	ACA[4]				Inglis and Howell 2009	Rollason and Howell 2012	DEE 2020a	DERM 2010	DES 2020a
						Adults typically found in or near estuaries, often around mangroves in clear or turbid water (Allen et al. 2002).							
Macquaria ambigua	Golden perch		LC		✓	Predominantly found in lowland warmer, turbid, slow-flowing rivers, often in association with structural woody habitat and other cover. A wide-ranging species with a natural distribution throughout the Murray-Darling, Fitzroy, Lake Eyre and Bullaroo River basins (Pusey et al. 2004).	**Potential**. The species habitat is known to occur in the broader search area, having been previously recorded by the project team within 10 km away.	**Known**. Species or species habitat not detected during field surveys.	✓				✓
Megalops cyprinoides	Oxeye herring/ tarpon		LC		✓	Juveniles and small adults occasionally occur within the freshwater reaches of coastal streams of Queensland; however,	**Unlikely**. Outside of normal area of distribution (ALA 2020). Preferred habitat does not occur within the Study area.	**Unlikely**. Species or species habitat not detected during field surveys.	✓	✓			✓

Scientific name	Common name	Status				Preferred habitat	Likelihood of occurrence within Study area based on desktop	Likelihood of occurrence within Study area post field survey	Data Source				
		EPBC Act[1]	NC Act[2]	Back on Track[3]	ACA[4]				Inglis and Howell 2009	Rollason and Howell 2012	DEE 2020a	DERM 2010	DES 2020a
						most commonly occurs in estuarine and marine waters (Allen et al. 2002).							
Mugil cephalus	Sea mullet		LC		✓	Found around the entire mainland coast of Australia, primarily occurring in brackish waters, although known to enter lower reaches of freshwater rivers (Allen et al. 2002).	**Unlikely**. Preferred habitat does not occur within the Study area.	**Unlikely**. Species or species habitat not detected during field surveys.	✓	✓			✓
Ophiocara porocephala	Spangled gudgeon		LC		✓	Distributed in brackish estuaries and river mouths; however, also found in freshwater bodies at low elevations around the northern and eastern coasts of Australia (Allen et al. 2002).	**Unlikely**. Preferred habitat does not occur within the Study area.	**Unlikely**. Species or species habitat not detected during field surveys.	✓	✓			

Scientific name	Common name	Status				Preferred habitat	Likelihood of occurrence within Study area based on desktop	Likelihood of occurrence within Study area post field survey	Data Source				
		EPBC Act[1]	NC Act[2]	Back on Track[3]	ACA[4]				Inglis and Howell 2009	Rollason and Howell 2012	DEE 2020a	DERM 2010	DES 2020a
Rhadinocentrus ornatus	Ornate rainbowfish		LC	H/ H	✓	Coastal lowland wallum and rainforest ecosystems; often in association with dense emergent and submerged vegetation / woody debris, leaf litter and undercut banks (Allen et al. 2002).	**Unlikely**. Preferred habitat does not occur within the Study area.	**Unlikely**. Species or species habitat not detected during field surveys.				✓	✓
Scleropages leichardti	Southern saratoga		LC		✓	Billabongs or large pools in slow-flowing streams, usually in turbid conditions. Often associated with abundant large in-stream wood, undercut banks and overhanging vegetation. Endemic to the Fitzroy River basin (Allen et al. 2002).	**Unlikely**. Preferred habitat does not occur within the Study area.	**Unlikely**. Species or species habitat not detected during field surveys.	✓	✓			✓

Scientific name	Common name	Status				Preferred habitat	Likelihood of occurrence within Study area based on desktop	Likelihood of occurrence within Study area post field survey	Data Source				
		EPBC Act[1]	NC Act[2]	Back on Track[3]	ACA[4]				Inglis and Howell 2009	Rollason and Howell 2012	DEE 2020a	DERM 2010	DES 2020a
Scortum hillii	Leathery grunter		LC		✓	Endemic to the Fitzroy River where it occurs in flowing freshwater streams and still pools. Most common in lower reaches of larger rivers and estuaries (Allen et al. 2002).	**Unlikely**. Preferred habitat does not occur within the Study area.	**Unlikely**. Species or species habitat not detected during field surveys.	✓	✓			✓
Strongylura krefftii	Freshwater longtom		LC		✓	Variety of habitats, including floodplain lagoons, main channels of rivers, sandy bed creeks and perennial escarpment streams (Pusey et al. 2004).	**Potential**. Natural distribution encompasses the Study area. Preferred habitat may occur within the Study area.	**Unlikely**. Species or species habitat not detected during field surveys.	✓	✓			✓
Trachystoma petardi	Pinkeye mullet		LC		✓	Deep, gently flowing rivers; as well as estuaries and coastal seas on the east coast of Australia (Allen et al. 2002).	**Unlikely**. Preferred habitat does not occur within the Study area.	**Unlikely**. Species or species habitat not detected during field surveys.	✓	✓			✓

Notes:

E = Endangered, V = Vulnerable, LC = Least Concern, C = Critical priority, H = High Priority, M = Medium Priority, P = Priority, R&T = Rare and Threatened.

1. EPBC Act = status under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*.
2. NC Act = status under the Queensland *Nature Conservation Act 1992*.
3. Back on Track = status under the DERM (2010) Fitzroy Natural Resource Management Region – Back on Track Actions for Biodiversity.
4. ACA = status under the Aquatic Conservation Assessments using AquaBAMM for riverine and non-riverine wetlands of the Great Barrier Reef catchments (Inglis and Howell 2009; Rollason and Howell 2012).

References:

- Inglis and Howell 2009, Aquatic Conservation Assessments using AquaBAMM for the riverine wetlands of the Great Barrier Reef catchment: Fitzroy region.
- Rollason and Howell 2012, Aquatic Conservation Assessments using AquaBAMM for the non-riverine wetlands of the Great Barrier Reef catchment: Fitzroy region
- Commonwealth Department of the Environment and Energy (DEE) 2019, EPBC Act Protected Matters Report – created 26/09/2019.
- Queensland Department of Environment and Resource Management (DERM) 2010, Fitzroy Natural Resource Management Region – Back on Track Actions for Biodiversity.
- Queensland Department of Environment and Science (DES) 2020a, Wetland*Info* – Fitzroy Basin – Wetland Summary Information.

Table 16 EVNT and Priority aquatic reptiles recorded from the desktop search area

Scientific name	Common name	Status				Preferred habitat	Likelihood of occurrence within Study area based on desktop	Likelihood of occurrence within Study area post field survey	Data Source				
		EPBC Act[1]	NC Act[2]	Back on Track[3]	ACA[4]				Inglis and Howell 2009	Rollason and Howell 2012	DEE 2020a	DERM 2010	DES 2020a
Rheodytes leukops	Fitzroy River turtle	V	V	H/ H	R & T	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 2020b).	**Unlikely**. Potential habitat does not occur within the Study area.	**Unlikely**. Species or species habitat not detected during field surveys.	✓		✓	✓	✓
Elseya albagula	Southern snapping turtle	C E	E	H/ H	P	Permanent flowing water habitats where there are suitable shelters and refuges (DES 2020g); clear, flowing, well-oxygenated waters (Todd et al. 2013) of the Fitzroy, Mary and Burnett catchments.	**Unlikely**. Potential habitat does not occur within Study area.	**Unlikely**. Species or species habitat not detected during field surveys.	✓		✓	✓	✓

Notes:

E = Endangered, V = Vulnerable, LC = Least Concern, C = Critical Priority, H = High Priority, M = Medium Priority, P = Priority, R&T = Rare and Threatened, Mi = Migratory.

1. EPBC Act = status under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*.
2. NC Act = status under the Queensland *Nature Conservation Act 1992*.
3. Back on Track = status under the DERM (2010) Fitzroy Natural Resource Management Region – Back on Track Actions for Biodiversity.

4. ACA = status under the Aquatic Conservation Assessments using AquaBAMM for riverine and non-riverine wetlands of the Great Barrier Reef catchments (Inglis and Howell 2009; Rollason and Howell 2012).

References:

- Inglis and Howell 2009, Aquatic Conservation Assessments using AquaBAMM for the riverine wetlands of the Great Barrier Reef catchment: Fitzroy region.
- Rollason and Howell 2012, Aquatic Conservation Assessments using AquaBAMM for the non-riverine wetlands of the Great Barrier Reef catchment: Fitzroy region
- Commonwealth Department of the Environment and Energy (DEE) 2019, EPBC Act Protected Matters Report – created 26/09/2019.
- Queensland Department of Environment and Resource Management (DERM) 2010, Fitzroy Natural Resource Management Region – Back on Track Actions for Biodiversity.
- Queensland Department of Environment and Science (DES) 2020a, Wetland*Info* – Mackenzie Sub-basin – Wetland Summary Information.

Table 17 Priority invertebrate species recorded from the desktop search area

Scientific name	Common name	Status				Preferred habitat	Likelihood of occurrence within Study area based on desktop	Likelihood of occurrence within Study area post field survey	Data Source				
		EPBC Act[1]	NC Act[2]	Back on Track[3]	ACA[4]				Inglis and Howell 2009	Rollason and Howell 2012	DEE 2020a	DERM 2010	DES 2020a
Euastacus eungella	Eungella spiny crayfish				✓	Only a small population restricted to localities >740 m above sea level in tropical rainforest headwaters and seepages in the Clarke Range, 65km west of Mackay (Coughran and Furse 2010).	**Unlikely**. Outside of known distributional range.	**Unlikely**. Species or species habitat not detected during field surveys.		✓			
Euastacus monteithorum	A spiny crayfish				✓	Cool, clear, fast-flowing headwaters in rainforest areas at >800 m above sea level. Prefers heavily shaded, well oxygenated waters where it can burrow under logs and rocks. Known from only one location: Kroombit Tops National Park, 62 km south-west of Gladstone (Coughran and Furse 2010).	**Unlikely**. Outside of known distributional range.	**Unlikely**. Species or species habitat not detected during field surveys.		✓			

Notes:

1. EPBC Act = status under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*.
2. NC Act = status under the Queensland *Nature Conservation Act 1992*.
3. Back on Track = status under the DERM (2010) Fitzroy Natural Resource Management Region – Back on Track Actions for Biodiversity.
4. ACA = status under the Aquatic Conservation Assessments using AquaBAMM for riverine and non-riverine wetlands of the Great Barrier Reef catchments (Inglis and Howell 2009; Rollason and Howell 2012).

4.8 Introduced Species

4.8.1 Introduced aquatic flora

There are 21 three introduced wetland indicator plant species known from the Fitzroy Basin (DES 2020a). Only one of these species was recorded in the Study area, being white eclipta (*Eclipta prostrata*). Those invasive species considered to pose a particular threat to aquatic biodiversity, and that could potentially occur within the Study area, are listed in Table 18 as either a Weed of National Significance (WoNS) (DEE 2020c) or Restricted matter category 3 under the Queensland *Biosecurity Act 2014*. No aquatic WoNS or Restricted matter species were detected in the Study area.

Table 18 Introduced wetland indicator plants known to occur in the desktop search area, and potentially in the Study area

Scientific name	Common name	National status^	Biosecurity Act status*
Arundo donax			
Cyperus esculentus	Yellow nutgrass		
Cyperus involucratus			
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			
Hymenachne aplexicaulis	Olive hymenachne	WoNS	Restricted 3
Juncus bufonius	Toad rush		
Nymphaea caerulea	Cape waterlily		
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		

Notes:

^ Species listed as WoNS; * species listed under the Queensland *Biosecurity Act 2014*.

4.8.2 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), as well as more recent records of tilapia (*Oreochromus mossambicus*) (Catchment Solutions 2015; DPM Enviros ciences 2018) and platy (*Xiphophorus maculatus*) (Catchment Solutions 2015) (Table 19). One pest fish species – mosquitofish – was recorded from the Mackenzie River Sub-basin (near Blackwater) in late 2019 (DPM Enviros ciences 2020). No pest fishes are yet recorded for the Mackenzie River Sub-basin in Wetland*Info* (DES 2020a).

An additional two pest fish species are identified in the ACA Expert Panel reports for the Fitzroy section of the GBR catchments (Inglis and Howell 2009; Rollason and Howell 2012): swordtail (*Xiphophorus helleri*) and spotted tilapia (*Tilapia mariae*). Each of these species are unlikely to occur in the Study area (Table 19).

4.8.3 Introduced aquatic reptiles

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

Table 19 Introduced fish species recorded from the Fitzroy Basin

Scientific name	Common name	Preferred habitat	Negative impacts on native fish	Likelihood of occurrence in the Study area based on desktop	Likelihood of occurrence in the Study area post field survey	Data Source				
						Inglis and Howell	Rollason and Howell	DES 2020a	DPM Enviro. 2018	Catchment Sol. 2015
Carassius auratus	Goldfish	Inhabits still or slow-flowing water. Able to withstand high temperatures and low dissolved oxygen. Often associated with aquatic flora (Lintermans 2007).	Typically referred to as a "benign" species, with few impacts recorded. However, introduced the "goldfish ulcer" disease to other fish (Lintermans 2007).	**Potential**. The species habitat is known to occur in the broader search area and there are records within 50 km of the Study area.	**Unlikely**. Species or species habitat not detected during field surveys.	✓	✓	✓		
Cyprinus carpio	European carp	Warm, slow-flowing lowland rivers or lakes; rarely found in clear, cool fast-flowing streams (Lintermans 2007).	Their feeding behaviour can increase turbidity and undermine banks; alter zooplankton and algal levels; and compete with native fish for food and space (Lintermans 2007)..	**Unlikely**. Preferred habitat does not occur within the Study area, and there are no records within 50 km of the Study area.	**Unlikely**. Species or species habitat not detected during field surveys.			✓		
Gambusia holbrooki	Mosquito fish	Often found in lakes or still/slow flowing water; typically around edges or vegetation. Tolerant of a wide range of water temperatures, oxygen	High ability to breed leads to plague number in many habitats. Aggressive species, chasing and fin-nipping other species. Prey on	**Potential**. The species habitat is known to occur in the broader search area and there are records within 50 km of the Study	**Unlikely**. Species or species habitat not detected during field surveys.	✓	✓	✓	✓	

Scientific name	Common name	Preferred habitat	Negative impacts on native fish	Likelihood of occurrence in the Study area based on desktop	Likelihood of occurrence in the Study area post field survey	Data Source				
						Inglis and Howell	Rollason and Howell	DES 2020a	DPM Enviro. 2018	Catchment Sol. 2015
		levels, salinities and turbidity (Lintermans 2007).	eggs of native fish and frogs, and native fish larvae. Implicated in the decline of over 30 fish species worldwide (Lintermans 2007).	area.						
Oreochromis mossambicus	Tilapia	Habitat variable, including reservoirs, lakes, ponds, rivers, creeks, drains, swamps and tidal creeks. Usually over mud bottoms, often in well-vegetated areas (Allen et al. 2002).	Competition with native species for food and space; predation upon the eggs and young of native species; aggressive behaviour toward native species; and destructive nest building by males (NSW DPI 2017).	**Unlikely**. Preferred habitat may occur within the Study area, but there are no records within 50 km of the Study area.	**Unlikely**. Species or species habitat not detected during field surveys.				✓	✓
Poecilia reticulata	Guppy	Wide variety of habitats – pristine to turbid, high to low elevations, fresh to brackish water; usually in small streams and amongst vegetation	No negative impacts yet known.	**Unlikely**. Preferred habitat may occur within the Study area, but there are no records within 50 km of the Study area.	**Unlikely**. Species or species habitat not detected during field surveys.	✓	✓	✓		

Scientific name	Common name	Preferred habitat	Negative impacts on native fish	Likelihood of occurrence in the Study area based on desktop	Likelihood of occurrence in the Study area post field survey	Data Source				
						Inglis and Howell	Rollason and Howell	DES 2020a	DPM Enviro. 2018	Catchment Sol. 2015
		(Lintermans 2007).								
Tilapia mariae	Spotted tilapia/ Black mangrove cichlid	Inhabits still or flowing waters in rocky or muddy substrates, tolerating a wide range of environmental conditions. Has little habitat requirements, variable dietary requirements and an ability to rapidly colonise a variety of habitats, including disturbed ecosystems (Bradford et al. 2011).	Competes for resources. Aggressive towards other fish species (Bradford et al. 2011).	**Unlikely**. Although identified in the ACAs (Inglis and Howell 2009, Rollason and Howell 2012), ALA (2020) identifies *T. mariae* as currently restricted to Brisbane, Townsville and Cairns.	**Unlikely**. Not detected during field surveys.	✓	✓			

Scientific name	Common name	Preferred habitat	Negative impacts on native fish	Likelihood of occurrence in the Study area based on desktop	Likelihood of occurrence in the Study area post field survey	Data Source				
						Inglis and Howell	Rollason and Howell	DES 2020a	DPM Enviro. 2018	Catchment Sol. 2015
Xiphophorus helleri	Swordtail	Favours warm water near edges of creeks and drains amongst weeds (Allen et al. 2002).	Competes with native fishes for resources. High fecundity and can quickly become the dominant species in a waterbody as a result (Allen et al. 2002).	**Unlikely**. Preferred habitat may occur within the Study area, but there are no records within 50 km of the Study area.	**Unlikely**. Not detected during field surveys.	✓	✓			
Xiphophorus maculatus	Platy	Occurs in a few creeks and swamps around Queensland, favouring warmer, static waters (Allen et al 2002).	Competes with native fishes for resources. High fecundity and can quickly become the dominant species in a waterbody as a result (Allen et al. 2002).	**Unlikely**. Preferred habitat may occur within the Study area, but there are no records within 50 km of the Study area.	**Unlikely**. Species or species habitat not detected during field surveys.	✓	✓			✓

References:

- Inglis and Howell 2009, Aquatic Conservation Assessments using AquaBAMM for the riverine wetlands of the Great Barrier Reef catchment: Fitzroy region.
- Rollason and Howell 2012, Aquatic Conservation Assessments using AquaBAMM for the non-riverine wetlands of the Great Barrier Reef catchment: Fitzroy region
- Queensland Department of Environment and Science (DES) 2020a, Wetland*Info* – Fitzroy Basin – Wetland Summary Information.

4.9 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 the potential GDEs and assess and manage potential impacts to GDEs (Independent Expert Scientific Committee [IESC] 2018).

GDEs are classed as either:

- surface GDEs – ecosystems dependent on the surface expression of groundwater, including:
  - river-base flow systems – aquatic and riparian ecosystems that exist in or adjacent to streams (including the hyporheic zone) fed by groundwater;
  - wetlands – aquatic communities and fringing vegetation dependent on groundwater-fed lakes and wetlands, including palustrine, lacustrine and riverine wetlands that receive groundwater discharge and can include some spring ecosystems;
  - ecosystems which rely on submarine discharge of groundwater for nutrients and/or physico-chemical attributes;
- subterranean GDEs – aquifer and cave ecosystems; and
- terrestrial GDEs – Ecosystems dependent on subsurface presence of groundwater (refer to the Terrestrial Ecology Assessment).

4.9.1 Surface expression GDEs

Quaternary alluvium is distributed within the Middlemount Coal Mine from Roper Creek in the south to Thirteen Mile Gully in the north, and is comprised of clay, silt and sand (AGE 2018). Where it occurs, the alluvium is thin, usually less than 5 m (Parsons Brinkerhoff 2010, cited in AGE 2020). Groundwater levels at the site are typically deeper than 10 m below ground level, which is below the base of the alluvium, indicating that the alluvium is typically unsaturated (AGE 2018).

Desktop mapping of potential surface GDEs throughout Queensland (DES 2019c) indicates aquatic ecosystems with moderate potential for groundwater interaction may occur approximately 3.8 km south of the Study area and 6 km west of the Study area (Figure 16). These are further identified as 'moderate confidence' 'Quaternary alluvial aquifers overlying sandstone ranges with fresh, intermittent groundwater connectivity regime' (DES 2019c). Neither are hydraulically connected to the Study area. No surface GDEs are mapped for the Study area (DES 2019c).

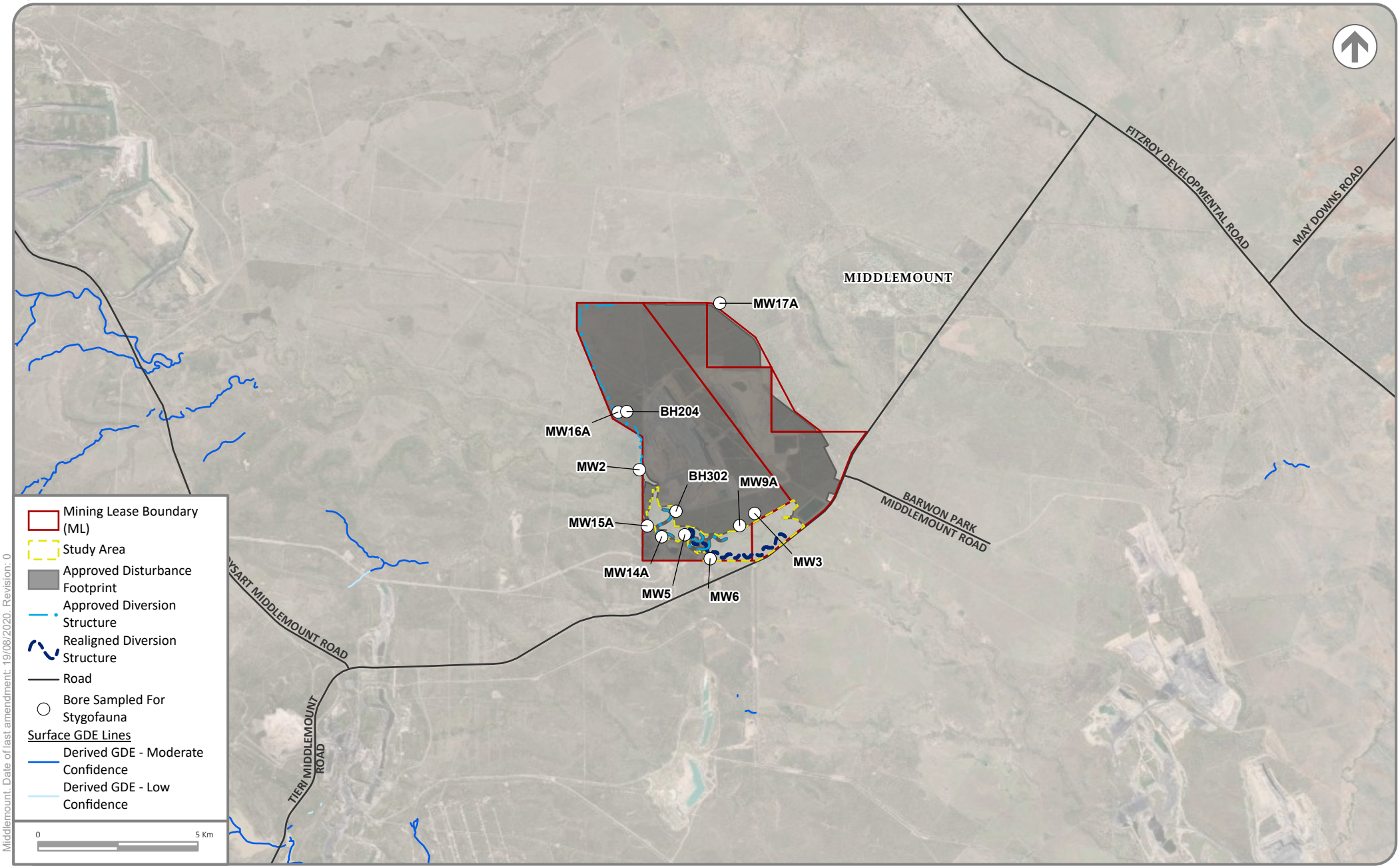
The Queensland Wetlands Map (DES 2019b) indicates no wetlands mapped for the Study area.

There are no known springs or seeps within the Study area and no obligatory surface GDEs have been identified within the Study area. The nearest mapped spring is associated with the Blackdown Tablelands National Park approximately 100 km south-south-east of the Study area.

Regionally, groundwater flow within the underlying aquifers is towards the south east (AGE 2018). Groundwater levels are generally in excess of 25 mbgl and separated from surface waters, limiting potential to support surface GDEs (AGE 2018). There are no springs from these deep confined aquifers within the Study area or surrounds that would support surface GDEs (AGE 2018).

No surface expression of groundwater (nor any other surface water) was encountered within Roper Creek or Thirteen Mile Gully at the time of assessment in October 2019. Surface water was encountered within Roper Creek at each of four sites assessed in February 2020, approximately four weeks following a rainfall and runoff event. Distinct differences in surface water and groundwater ionic compositions in samples collected in February 2020 further highlight the unlikely interaction of surface water and groundwaters of the Study area (Figure 9 and Figure 10, Section 4.2.2).

Prolonged dry conditions in the lead-up to the October 2019 surveys provided ideal conditions for detecting groundwater surface expressions. However, no flows, salt seeps, hydrophytes or other obvious indicators of surface expression GDEs were encountered within the Study area. The October 2019 and February 2020 surveys identified species of semi-aquatic macrophytes typical of ephemeral drainage lines of the broader Fitzroy River catchment, with no evidence of river-base flow systems or groundwater-fed wetlands within the Study area.



Middlemount. Date of last amendment: 19/08/2020. Revision: 0

DPM ENVIROSCIENCES

STATE MAPPED SURFACE EXPRESSION GROUNDWATER DEPENDENT ECOSYSTEMS

Middlemount Coal Mine Southern Extension Project

FIGURE 16

4.9.2 Subterranean GDEs

Desktop review results

As described in Section 3.4.2, the desktop review involved:

- assessing the suitability of local habitat for stygofauna based on local geological and hydrological conditions; and
- determining the presence and composition of stygofauna in the region and Study area based on previous studies.

Aquifers of the Study area

The surface geology of the Study area is dominated by Quaternary alluvium, with some Tertiary sedimentary rock in the south (Figure 17). This is underlain by Permian age coal measures. Broad-scale potential GDE aquifer mapping for Queensland (DES 2019c) identifies a 'low confidence' unconsolidated sedimentary aquifer beneath most of the Study area (Figure 18); more specifically, a 'Quaternary alluvial aquifer with fluctuating, intermittent groundwater connectivity regime and unknown pH'.

Site-specific assessments indicate that aquifers of the Study area and surrounds can be separated into the following three key hydro-stratigraphic units based on their hydraulic properties and lithology (AGE 2018):

- Quaternary alluvial aquifer – consists of localised stream channel deposits and associated floodplain deposits. These units comprise a temporary (rainfall dependent) aquifer that is limited to the immediate vicinity of Roper Creek, Thirteen Mile Gully and drainages within the MLs. The Quaternary alluvium is not a productive aquifer within the Study area and no monitoring bores have been installed within the Quaternary alluvium.
- Tertiary Duaringa Formation aquifer / aquitard – consists of thick clay-rich laterite which is sourced from highly weathered Permian sandstones and siltstones, and occasional basalt. The Duaringa Formation is not typically targeted for agricultural water supply and is (at best) a low yielding aquifer that would more commonly be regarded as an aquitard.
- Permian coal measures aquifer – the bulk of the Permian coal measures strata is sandstone, siltstone and mudstone (interburden / overburden) with typically low permeability, generally forming aquitards. Coal seams form low to moderate yielding aquifers confined by the interburden / overburden units.

Stygofauna Potential Presence

GHD conducted a stygofauna pilot study at Middlemount Coal Mine in 2012 in accordance with guidelines relevant at the time (WA EPA 2003 and WA EPA 2007, cited in GHD 2013). The sampling was undertaken to fulfil condition W69 of EA MIN100646307 at the time. The pilot study involved sampling ten bores within and surrounding the current Study area, detecting groundwater invertebrates in seven out of ten bores sampled, including:

- Cladocerans (water fleas) in the taxonomic family Chydoridae – a component of wetlands and still waterbodies with certain taxa also occurring in groundwater environments; however, the specimens collected had eyes, and are therefore not specifically adapted to permanently occupying the hyporheic or deep groundwater environments (GHD 2013).
- Copepods in the taxonomic family Cyclopidae – normally associated with fine to course sandy substrates of still water environments of rivers, wetlands, the hyporheic zone and shallow groundwaters (GHD 2013).

- Oligochaetes (segmented worms) in the family Naididae – members of the community that occurs within the shallow to deep sand and gravel beds associated with areas of groundwater discharge (Gilbert et al. 1994, cited in GHD 2013), representing a common group of worms existing in all Australian States and Territories (GHD 2013). However, subsequent studies now consider Oligochaetes as part of the soil fauna (Halse and Pearson 2014).

GHD (2013) concluded that the relative consistency of the faunal composition across the bores sampled suggests that the subterranean community diversity was naturally low, at least at the family level.

AGE (2018) conducted a groundwater assessment for the adjoining Western Extension Project, including consideration of bores installed up to 2015. AGE (2018) report that a number of bores around the MCM were sampled for stygofauna in 2011 (presumably by AGE). Invertebrate fauna from two classes / subclasses (Copepoda and Oligochaeta) were identified from bores in and outside the maximum zone of drawdown (e.g. some 5-7 km north-west and south-east) (AGE 2018). It is not known what bores AGE refer to. However, AGE (2018) concluded that the Western Extension Project is unlikely to significantly impact stygofauna, considering the Project would only incrementally increase the groundwater drawdown from the approved mine, the groundwater aquifer (similar stygofauna habitat) is extensive outside of the maximum zone of drawdown, and the sampling indicates there is a low diversity of subterranean fauna in and outside the maximum zone of drawdown (AGE 2018).

Previous studies undertaken by GHD (2013) and AGE (2018 [2011]) detected subterranean fauna (including potential stygofauna) in bores of the Study area and surrounds. Consequently, further sampling was undertaken with the aim of achieving better taxonomic resolution of any captured stygofauna required by the current guideline (DSITI 2015).

Stygofauna sampling results

Of the seven bores (MW2, MW4, MW5, MW5M, MW7M, TRI and DERM 1) determined by GHD (2013) to contain subterranean fauna in 2012, three were targeted for sampling in October 2019 – MW2, MW4 and MW5 (Table 5 and Table 20). Bores MW5M and MW7M were considered unsuitable for sampling, as although standing water levels of approximately 37 mbgl and 35 mgbl were encountered at the time of sampling in 2012, their screened intervals of 127-130 mbgl and 132-134.5 mbgl make them unsuitable. The invertebrate fauna collected from these bores is unlikely to reflect fauna in the aquifer. The location or construction details of TRI and DERM 1 could not be located in the Queensland Globe bore mapping, nor in the groundwater assessment (AGE 2018).

October 2019 sampling

A total of 11 groundwater bores were sampled for stygofauna in October 2019, as shown in Table 20. Standing water levels ranged from 8.57 mbgl at MW15A to 40.64 mbgl at MW5. pH levels ranged from 6.6 (neutral) at bore MW17A to 7.8 (mildly alkaline) at bore BH204 (Table 20). EC levels ranged from 5,261 µS/cm (slightly saline) at bore BH204 to 32,240 µS/cm (saline) at bore MW6.

The sample collected from bore MW2 contained segments of ants and subterranean termites. Bore MW3 contained segments of termites. Bore MW6 contained segments of ants. The sample collected from MW15A contained a terrestrial thrip (Thysanopteran), a segmented worm (Oligochaete) from the family Enchytraeidae, and two millipedes (Diplopods) from the family Paradoxosomatidae. The sample from bore MW17A contained a terrestrial springtail (Collembolan) from the family Isotomidae, as well as fragments of ants.

Although a number of invertebrates were identified from the samples collected in October 2019, no stygofauna were detected.

February 2020 sampling

Ten groundwater bores were sampled for stygofauna in February 2020, as shown in Table 21. Standing water levels ranged from 8.62 mbgl at MW15A to 45.01 at MW5. pH levels ranged from 6.3 (slightly acidic) at bore MW17A to 7.9 (moderately alkaline) at bore MW2 (Table 21). Specific conductivity levels ranged from 6,452 µS/cm (slightly saline) at bore MW16A to 31,846 µS/cm (saline) at bore MW6.

The sample collected from bore MW2 contained a terrestrial springtail (Collembolan) from the family Isotomidae and a soil-dwelling pseudo-centipede of the class Symphyla (Plate 2). Bore MW6 contained an astigmatid soil mite (Plate 2) and terrestrial invertebrate segments. Bore MW9A contained terrestrial insect head capsules. The sample collected from MW15A contained a toothed section of terrestrial invertebrate, possibly part of a cricket [Gryllactididae] leg. Bore MW17A contained another terrestrial insect segment.

Terrestrial Symphylan collected from bore MW2

Terrestrial astigmatid soil mite from bore MW6

Plate 2 Terrestrial invertebrates sampled from bores in the Study area, February 2020

Although a number of invertebrates were identified from the samples collected in February 2020, no stygofauna were detected.

The lack of Cladocerans (water fleas) and Copepods in the samples collected in October 2019 and February 2020 (when compared to those collected by GHD in December 2012) may be due to a number of factors, including varying climatic conditions affecting these common taxa known for their boom and bust cycles (James et al. 2008).

Table 20 Characteristics of groundwater monitoring bores sampled for stygofauna, October 2019

Bore ID^	Lithology at screened interval	Bore depth (mBGL)	Screen (mBGL)	SWL (mBGL)	Date sampled	pH	EC* (µS/cm)	Stygo. sampling	Notes
MW2^	Tertiary sandy clay and sand	27.37	21-29	17.51	15/10/19	7.01	9,254	✓	Six hauls off bottom. Purged by 4T 18/09/19.
MW3	Tertiary clay and sandy clay	46.80	39-47	23.56	16/10/19	6.86	22,682	✓	Six net hauls off the bottom of bore.
MW4^	Permian coal / weathered basalt	50.45	41-50	37.80	15/10/19	-	-	x	No sample. Impassable obstruction 27.5 mbgl.
MW5^	Permian coal	45.88	40-46	40.64	16/10/19	6.80	16,078	✓	Poor sample. Obstruction 35 mbgl. One bailer and one haul only.
MW6	Tertiary clay	41.15	37-42	28.98	16/10/19	6.89	32,240	✓	Six net hauls off the bottom of bore.
MW9A	Tertiary sandstone / siltstone	52.27	40-52	26.33	15/10/19	7.00	28,480	✓	Six net hauls off the bottom of bore.
MW11A	Tertiary clay / mudstone	13.47	10.5-13.5	Dry	15/10/19	-	-	x	No sample. Dry.
MW14A	Tertiary sand / mudstone	13.97	6-9	8.64	16/10/19	6.74	25,014	✓	Six net hauls off the bottom. Abundant root matter.
MW15A	Tertiary sand / sandy clay / mudstone	11.20	7-10	8.57	14/10/19	7.36	5,294	✓	Six net hauls off the bottom of bore.
MW16A	Tertiary sandstone	51.90	44-50	26.17	16/10/19	7.19	8,494	✓	Six net hauls off bottom. Coal fines. Sulphurous.
MW17A	Permian claystone / sandstone	42.68	36.5-42.5	35.95	15/10/19	6.55	19,116	✓	Six net hauls off the bottom of bore.
BH204	Tertiary sandy clay and mudstone	50.15	37.5-43.5	26.53	15/10/19	7.75	5,261	✓	Poor sample. Obstruction. One bailer and one haul only.
BH302	Tertiary sandstone	40.93	28.1-31.0	39.07	14/10/19	6.76	5,890	✓	Six net hauls off bottom. Sulphurous.

Notes: ^ Indicates bores in which subterranean fauna were detected by GHD in 2012 (GHD 2013); * EC = Electrical Conductivity, standardised to 25˚C (i.e. Specific Conductivity).

Table 21 Characteristics of groundwater monitoring bores sampled for stygofauna, February 2020

Bore ID^	Lithology at screened interval	Bore depth (mBGL)	Screen (mBGL)	SWL (mBGL)	Date sampled	pH	EC (µS/cm)	Ion sample	Stygo. sampling	Notes
MW2^	Tertiary sandy clay and sand	27.37	21-29	17.47	21/02/20	7.94	11,770	#	✓	Six hauls off bottom, then purged/filtered 20 L.
MW3	Tertiary clay and sandy clay	46.80	39-47	23.57	19/02/20	6.77	22,653	✓	✓	Six hauls off bottom, then purged/filtered 20 L.
MW4^	Permian coal / weathered basalt	50.45	41-50	38.18	21/02/20	6.79	21,683	x	x	Obstruction at about 40 mbgl.
MW5^	Permian coal	45.88	40-46	45.01	21/02/20	7.08	16,212	✓	✓	Net obstructed at 35 mbgl. 1.5 L extracted with bailer.
MW6	Tertiary clay	41.15	37-42	30.12	20/20/20	6.98	31,846	✓	✓	Six hauls off bottom, then purged/filtered 20 L.
MW9A	Tertiary sandstone / siltstone	52.27	40-52	27.01	20/02/20	7.18	27,938	✓	✓	Six hauls off bottom, then purged/filtered 20 L until dry.
MW14A	Tertiary sand / mudstone	14.00	6-9	9.06	21/02/20	6.84	30,182	✓	✓	Six hauls off bottom, then purged/filtered 9.5 L until dry.
MW15A	Tertiary sand / sandy clay / mudstone	11.18	7-10	8.62	20/02/20	7.42	7,250	✓	✓	Six hauls off bottom, then purged/filtered 13 L until dry.
MW16A	Tertiary sandstone	51.90	44-50	26.06	21/02/20	7.84	6,452	✓	✓	Six hauls off bottom, then purged/filtered 20 L.
MW17A	Permian claystone / sandstone	42.68	36.5-42.5	36.01	20/02/20	6.34	18,836	✓	✓	Six hauls off bottom, then purged/filtered 20 L.
BH302	Tertiary sandstone	40.93	28.1-31.0	39.24	20/02/20	6.86	8,018	✓	✓	Six hauls off bottom, then purged/filtered 3 L until dry.

Notes:

^ Indicates bores in which subterranean fauna were detected by GHD in 2012 (GHD 2013);

* EC = Electrical Conductivity, standardised to 25˚C (i.e. Specific Conductivity);

Sampled, but sample integrity compromised when left out of fridge; subsequently discarded.

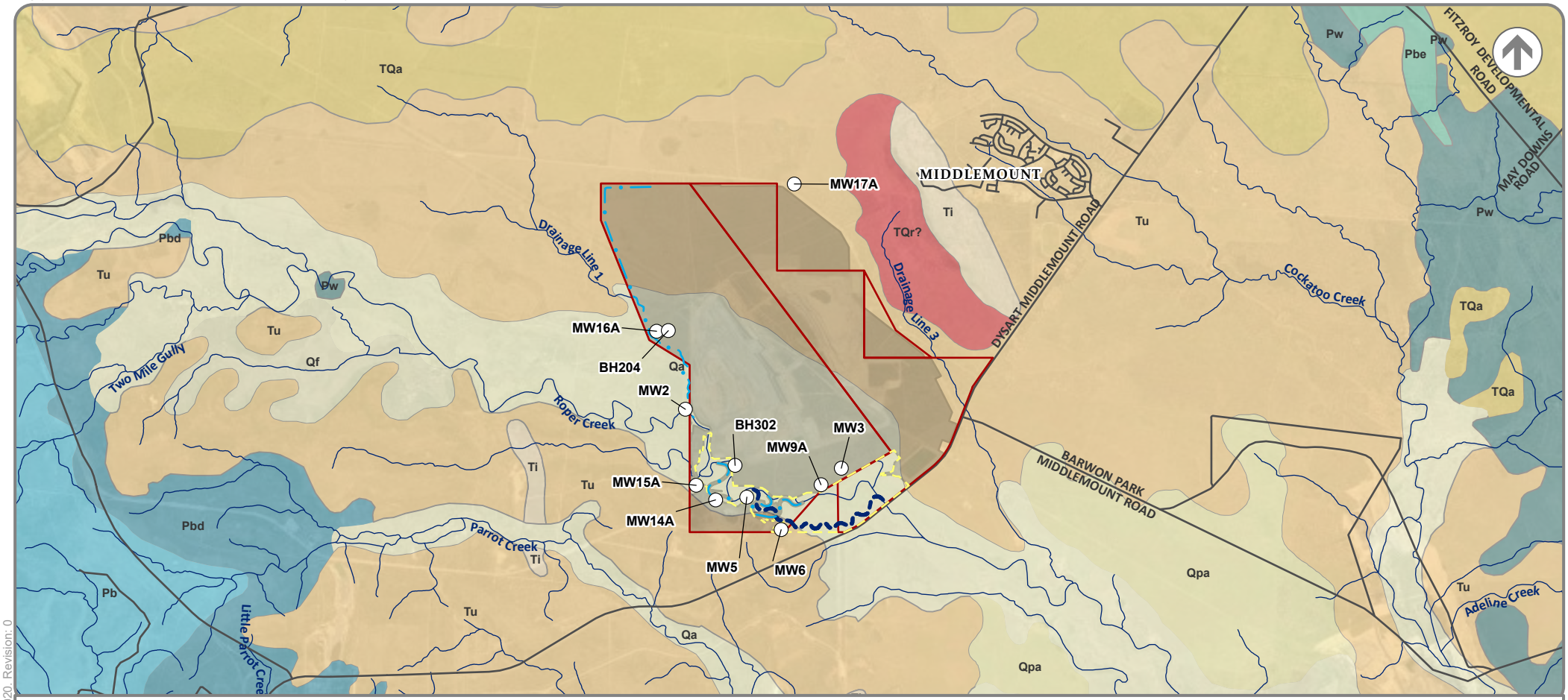
Ecosystem value of potential subterranean GDEs

No stygofauna were detected in targeted sampling by DPM Enviros ciences within and surrounding the Study area in October 2019 and February 2020.

Previous studies undertaken by GHD (2013) and AGE (2018 [2011]) detected Oligochaetes (segmented worms), cladocerans (water fleas) and copepods in groundwater bores within the Study area and surrounds. GHD (2013) concluded that the relative consistency of the faunal composition across the bores sampled suggests that the subterranean community diversity was naturally low. Oligochaetes are no longer considered stygofauna (Halse and Pearson 2014). Cladoceran and copepod micro-crustacea are prevalent throughout waterways, wetlands, hyporheic zones and shallow groundwaters of Australia, and their detection in floodplain bores is not evidence of a subterranean GDE.

It is unlikely that subterranean GDEs occur within the Study area. However, should they occur, they would be attributed a Low Ecological Value based on the following considerations, consistent with Serov 2012:

- uniqueness – lack of distinct or unique features, animals or habitats that aren't otherwise found in the broader area;
- condition – unlikely to be considered natural, considering potential drawdown impacts associated with the adjoining approved mining operation;
- vital habitat – unlikely to provide vital habitat for species of conservation significance in Queensland;
- representativeness – unlikely to represent an especially outstanding example of a subterranean GDE.
- Lack of *High Ecological Value* or *Moderate Ecological Value* attributes identified by Serov (2012).



Mining Lease Boundary (ML)
Study Area
Approved Disturbance Footprint
Realigned Diversion Structure
Approved Diversion Structure
Bore Sampled For Stygofauna
Waterway
Road

Surface Geology

Pb - Quartzose to lithic sandstone, siltstone, carbonaceous shale, minor coal and sandy coquinite

Pbd - Quartzose to sublabile, locally argillaceous sandstone, lithic and feldspathic sandstone, siltstone, mudstone, carbonaceous mudstone and coal

Pbe - Carbonaceous and micaceous labile sandstone, siltstone, shale, coquinite, minor conglomerate

Pw - Feldspathic and lithic sandstone, silty sandstone, calcareous sandstone, ashstone and cherty mudstone, carbonaceous mudstone and coal; commonly abundant plant fossils and fossil wood

Qa - Clay, silt, sand and gravel; flood-plain alluvium

Qf - Clay, silt, sand and clayey to sandy gravel; alluvial fans, sheetwash and floodout sheets

Qpa - Clay, silt, sand and gravel; flood-plain alluvium on high terraces

TQa - Locally red-brown mottled, poorly consolidated sand, silt, clay, minor gravel; high-level alluvial deposits (generally related to present stream valleys but commonly dissected)

TQr? - Clay, silt, sand, gravel, soil; colluvial and residual deposits

Ti - Intrusive rhyolite, trachyte and microsyenite

Tu - Mudstone, sandstone, conglomerate, siltstone, oil shale, lignite, basalt

0 4 Km

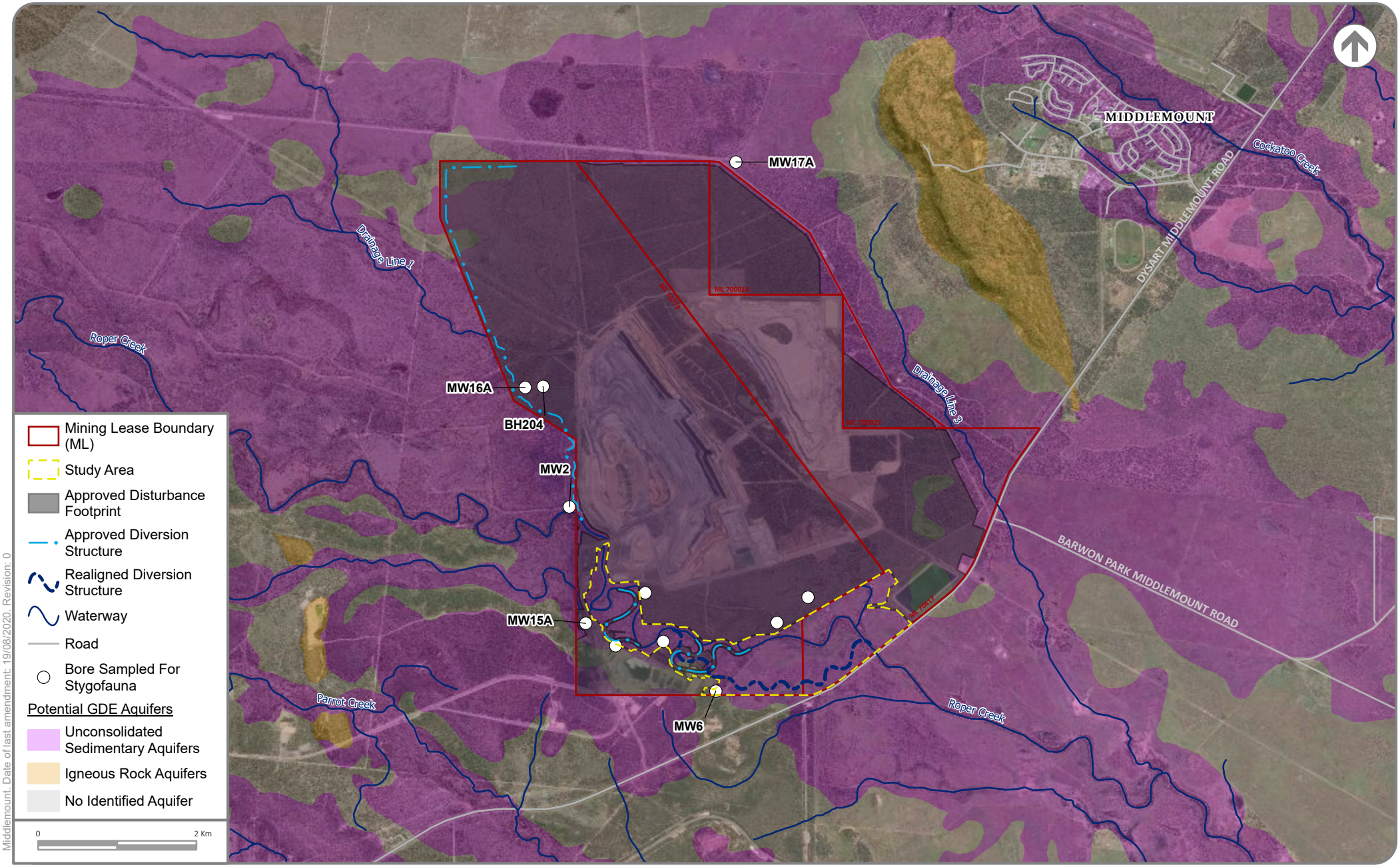
Middlemount. Date of last amendment: 19/08/2020. Revision: 0

DPM ENVIROSCIENCES

SURFACE GEOLOGY AND STYGOFAUNA SAMPLING LOCATIONS

Middlemount Coal Mine Southern Extension Project

FIGURE 17



Middlemount. Date of last amendment: 19/08/2020. Revision: 0

STATE MAPPED POTENTIAL GROUNDWATER DEPENDENT ECOSYSTEM AQUIFERS AND STYGOFAUNA SAMPLING LOCATIONS

Middlemount Coal Mine Southern Extension Project

FIGURE 18

4.10 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* (DEE 2020a). Wetlands of International Importance nearest to the search area include those of the Shoalwater and Corio Bays Area, approximately 160 km east-north-east of the Study area. These wetlands are well removed from the Study area, and are hydraulically connected only with the Coral Sea.

Threatened Ecological Communities

No EPBC Act listed Threatened Ecological Communities (TECs), relevant to aquatic ecology, are identified from the search area (DEE 2020a). No aquatic TECs are expected to occur within the Study area, and none were identified during the field surveys.

Threatened species

No MNES aquatic flora or fauna were detected during surveys.

Aquatic faunal species that are MNES are 'likely' to occur in the broader desktop search area (DEE 2020a). This includes the Critically Endangered southern snapping turtle (*Elseya albagula*) 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 since habitat for these species was not encountered within the Study area.

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

Migratory species

No aquatic migratory species (i.e. migratory species that live in water for most or all of their lives) were identified from the search area.

Commonwealth Marine Areas

The Study area is located approximately 120 km south-west of any marine area and is separated hydraulically by the Fitzroy River drainage sub-basin. Commonwealth marine areas are well removed from the Study area.

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, has been indicated as a controlling provision in the referral decision notice for the Middlemount Coal Mine Southern Extension Project. It will be addressed in a separate report as per the Information Guidelines for Independent Expert Scientific Committee advice on coal seam gas and large coal mining development proposals (IESC 2018).

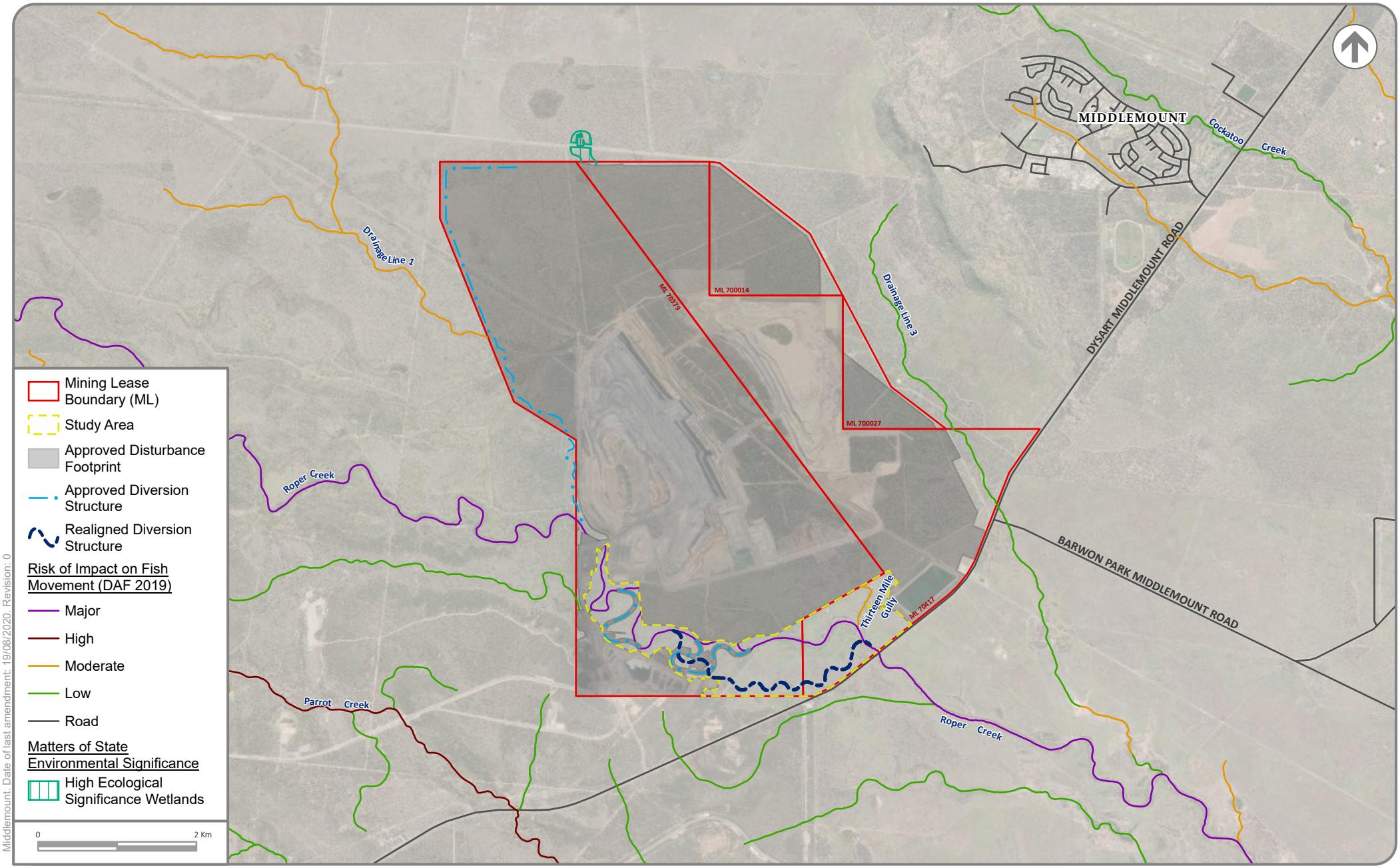
4.11 Matters of State Environmental Significance

The environmental offsets framework in Queensland includes the *Environmental Offsets Act 2014* (EO Act), the *Environmental Offsets Regulation 2014* (EO Regulation) and the *Queensland Environmental Offsets Policy* (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.

A number of MSES were identified during the desktop review as occurring within the Study area. MSES of relevance to this aquatic ecology assessment comprise 'waterways providing for fish passage' (Table 22).

Table 22 Matters of State Environmental Significance

Prescribed Environmental Matter	Present in the Study area	Detail
Regulated vegetation	Yes	Refer to Terrestrial Ecology Assessment.
Connectivity areas	-	Refer to Terrestrial Ecology Assessment.
Wetlands and watercourses	No	The Study area does not contain any wetlands or watercourses in 'high ecological value waters' nor 'high ecological significance wetlands'.
Protected Wildlife Habitat	No	Refer to terrestrial ecology assessment.
Koala Habitat in South-East Queensland	No	The Study area is not located in South-east Queensland
Protected Areas	No	The Study area does not contain protected areas.
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 (Figure 8).
Marine Plants	No	The Study area is not located in a marine environment.
Secured Offset Area	No	The Study area does not contain legally secured offset areas.



Middlemount. Date of last amendment: 19/08/2020. Revision: 0

DPM ENVIROSCIENCES

AQUATIC MATTERS OF STATE ENVIRONMENTAL SIGNIFICANCE

Middlemount Coal Mine Southern Extension Project

FIGURE 19

5 POTENTIAL IMPACTS

5.1 Aquatic habitat clearance

The transient flow, lack of pools and lack of dry season refuge in the Project area limits the ability of Roper Creek and Thirteen Mile Gully to provide sustained habitat for native fish and turtles. These habitats are not expected to support aquatic species of conservation significance listed under the NC Act or EPBC Act, given the lack of suitable habitat features (Section 4.7). However, the Project would still remove or otherwise interfere with aquatic habitat in the Project area, comprising ephemeral watercourses and drainage lines.

5.1.1 Aquatic habitat

Direct impacts as a result of the Project would include the removal of aquatic and riparian habitat within an approximate 4.5 km reach of Roper Creek and development of a diversion for this section of Roper Creek, which would be approximately 3.8 km long. It is noted however that the approved Roper Creek Diversion 2 will remove approximately 1.9 km of aquatic and riparian habitat (i.e. the Project would result in an additional 2.6 km of Roper Creek being diverted).

The Project would also include removal of a small section (approximately 1 km) of the old Thirteen Mile Gully, the upstream catchment of which has previously been diverted along the western boundary of ML 70379 (Figure 8) (Section 4.1.1).

5.1.2 Aquatic flora

All aquatic floral species detected during the surveys are ‘Least Concern’ under the NC Act. No conservation significant aquatic floral species listed under the NC Act were detected within the Project area.

One Priority aquatic floral species was detected, being tall flatsedge (*Cyperus exaltatus*), recorded at each survey site. Tall flatsedge is considered a Priority species in non-riverine wetlands of the GBR catchments due to its tendency to form significant macrophyte beds, providing important habitat and a food source for fauna (Rollason and Howell 2012). Aquatic flora present within the Project area would be impacted by a loss of habitat along the 4.5 km impacted reach of Roper Creek, and the 1 km reach of Thirteen Mile Gully.

5.1.3 Aquatic fauna

All aquatic fauna species detected during the surveys are Least Concern under the NC Act. No aquatic fauna species listed under the NC Act, or Priority fauna species, were detected. Aquatic fauna present within the Project area would be impacted by a loss of habitat along the 4.5 km impacted reach of Roper Creek, and the 1 km reach of Thirteen Mile Gully.

The species detected within the Project area are common and have a broad distribution in the region. Hence, the removal of these habitat areas from the Project area is unlikely to have a significant impact on these species.

Waterways for fish passage

Roper Creek is mapped as being at ‘major’ risk of adverse impact from waterway barrier works on fish movement (Figure 8), necessitating the need for diverted stream reaches to be as similar to the existing channels as possible in accordance with Australian Coal Association Research Program (ACARP) stream diversion design criteria.

5.2 Surface water

Surface water quality and flows are relevant to the health and productivity of aquatic ecosystems. The following sections (5.2.1 and 5.2.2) discuss surface water and potential impacts of the Project on surface water from an ecological perspective. These sections draw on the key conclusions from the *Middlemount Coal Mine Southern Extension Project Surface Water Assessment* (WRM 2020) and the *Middlemount Coal Mine Southern Extension Project: Groundwater Impact Assessment* (AGE 2020).

5.2.1 Water quality

The physico-chemical water quality in Roper Creek is characterised by high and variable turbidity, moderate and variable EC, pH levels generally within the recommended range, and low DO concentrations at times (DPM Enviroscienses 2019). These fluctuations in physico-chemical water quality may be temporary in nature and may be explained by the ephemeral nature of Roper Creek, high intensity rainfall events, upstream activities or localised impacts from cattle accessing waterways, or a combination of these factors.

Erosion and Sedimentation

Contaminated runoff can impact receiving environments. An operation and monitoring plan would be developed for the proposed realignment of the Roper Creek Diversion 2 as part of detailed design. This plan would be consistent with the monitoring program previously developed for the existing Thirteen Mile Gully Diversion to address the potential for such impacts. A 'best practice' approach would be adopted which is consistent with the International Erosion Control Association Australasia (IECAA) recommendations. The following broad principles would apply:

- minimise the area of disturbance;
- where possible, apply local temporary erosion control measures;
- intercept runoff from undisturbed areas and divert around disturbed areas; and
- where temporary measures are likely to be ineffective, divert runoff from disturbed areas to sedimentation basins prior to release from the site.

If implemented effectively, water quality impacts are expected to be minimal and hence environmental risks to water quality from disturbed area runoff are expected to be low.

Mine Water Discharge

There are seven licensed release points that each discharge into Roper Creek, either directly or via an unnamed drainage feature upstream of Roper Creek (DES 2019f). No additional mine affected water discharge points are proposed.

Leaks and Spills

Leaks or spills of hydrocarbon-based fluids from construction equipment and spread of coal dust represents a potential risk to aquatic habitat downstream of the Project. However, Middlemount Coal Mine has well established procedures to handle inadvertent leaks and spills. Given the implementation of suitable management measures, including implementation of a spill response and appropriate water management system, there is a low risk of this event (or one similar) occurring. The Project is unlikely to result in leaks / spills that would eventuate in serious environmental harm to aquatic species or their habitat.

5.2.2 Water flow

The waterways of the Project area are ephemeral, only flowing after largely unpredictable rainfall and runoff, ceasing to flow within days, supporting aquatic life whose life cycles are adapted to these conditions (Section 4.1). Intermittent pools persist at some locations for a matter of weeks following a flow event. These surface flows are enough for some semi-aquatic plants and macroscopic animals to complete the aquatic stages of their life cycles, as well as allowing for fish passage upstream and downstream of the Project area.

The flow of water in Roper Creek would be affected by the construction of a permanent watercourse diversion. During active mining operations, the mine water management system would capture runoff from areas that would have previously flowed to Roper Creek. The maximum captured catchment areas represent less than 0.3% (WRM 2020) of the Roper Creek catchment to the downstream boundary of the Middlemount Coal Mine.

5.3 Groundwater dependent ecosystems

5.3.1 Surface expression GDEs

No indicators of surface expression GDEs were encountered within the Study area as part of the desktop assessment or field surveys (Section 4.9.1). Desktop mapping of potential surface expression GDEs throughout Queensland (DES 2019c) indicates that aquatic ecosystems with moderate potential for groundwater interaction may occur approximately 3.8 km south of the Project area and 6 km west of the Project area (Figure 16). These are further identified as ‘moderate confidence’ ‘Quaternary alluvial aquifers overlying sandstone ranges with fresh, intermittent groundwater connectivity regime’ (DES 2019c). Since, neither are hydraulically connected to the Project area, no measurable impacts on these or other potential surface expression GDEs are likely to occur.

5.3.2 Subterranean GDEs

No stygofauna were detected from targeted sampling within and surrounding the Study area (Section 4.9.2). It is unlikely that subterranean GDEs occur within the Study area. However, should they occur, they would be attributed a Low Ecological Value based on considerations of Serov 2012 (Section 4.9.2).

The Project is unlikely to significantly impact stygofauna, considering the Project would only incrementally increase the groundwater drawdown from the approved mine (AGE 2020), the groundwater aquifer (similar potential habitat) is extensive outside of the maximum zone of drawdown, and the non-detection suggests that stygofauna are unlikely to occur within the Project area.

5.4 Cumulative impacts

The Project is located within the headwaters of the Mackenzie River drainage sub-basin of the greater Fitzroy Basin. The major rivers and tributaries of the Fitzroy catchment include the Fitzroy, Dawson, Nogoa, Comet, Isaac and Mackenzie Rivers.

Roper Creek transects the Project area, as does Thirteen Mile Gully and an unnamed tributary, both of which flow into Roper Creek. Downstream of Middlemount Coal Mine, Roper Creek passes through Foxleigh Coal Mine which flows into Oaky Creek approximately 37 km downstream of the Project area, before reaching the Mackenzie River approximately 20 km further downstream.

The site water management system has been designed such that the risk of off-site uncontrolled release of mine affected water during operations will be very low and sediment inputs can be controlled through drainage, and erosion and sediment control measures. On this basis, the Project is not expected to make a significant contribution to cumulative sediment loads in the Fitzroy River Basin (WRM 2020).

Given that the Project mine affected water releases would be managed within an overarching strategic framework for management of cumulative impacts of mining activities, the proposed management approach for mine water from the Project is expected to have negligible cumulative impact on surface water quality and associated aquatic habitat values (WRM 2020).

The Project is unlikely to result in a significant cumulative impact to the aquatic flora and fauna of the Mackenzie River system, given the limited potential impacts associated with the Project and the implementation of mitigation and management measures described in Section 6.

5.5 Impacts on Matters of National Environmental Significance

There were no MNES related to aquatic ecology recorded within the Project area or surrounds. As such, it is concluded that the Project is unlikely to have a significant impact on MNES relevant to aquatic ecology.

5.6 Impacts on Matters of State Environmental Significance

The Queensland Environmental Offsets Policy Significant Residual Impact Guideline (DEHP 2014) is used to determine if a prescribed activity would have a significant residual impact on MSES. A significant residual impact is defined as an adverse impact, whether direct or indirect, of a prescribed activity on all or part of a prescribed environmental matter that:

a) remains, or will or is likely to remain (whether temporarily or permanently), despite on-site avoidance and mitigation measures for the prescribed activity; and

b) is, or will or is likely to be significant.

There is one potential MSES relevant to aquatic ecology that is known to occur in the Project area that may be subject to impacts from the Project, being Waterways Providing for Fish Passage (Section 4.11). Potential impacts on this MSES is discussed below.

Table 23 Waterways Providing for Fish Passage Significant Residual Impact Assessment

Criteria	Assessment / consideration
An action is likely to have a significant impact on a waterway providing fish passage if there is a real possibility that the action will:	
Result in the mortality or injury of fish	The Project is unlikely to result in barriers that cause the mortality or injury of native fish because: ▪ waterway (including diversion channel) crossings would be constructed with consideration to fish passage requirements in the *Accepted Development Requirements for Operational Work that is Constructing or Raising Waterway Barrier Works* (DAF 2017), so as not to create a barrier to fish movement; and ▪ the diversion of Roper Creek would be sensitively designed to replicate natural features where possible and provide similar conditions to the original waterway, including stream hydraulics, geomorphology, instream habitat, bank profiles and bank vegetation, to provide habitat and refuge for fish inhabiting or passing through the diversion of Roper Creek.
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.	The Project is unlikely to result in conditions that would substantially increase risks to the health, wellbeing and productivity of fish seeking passage because: ▪ waterway (including diversion channel) crossings would be constructed so as not to create a barrier to fish movement; and ▪ the diversion of Roper Creek would be designed to replicate similar conditions to the original waterway, including stream hydraulics, geomorphology, instream habitat, bank profiles and bank vegetation, to provide habitat and refuge for fish inhabiting or passing through the diversion of Roper Creek.
Reduce the extent, frequency or duration of fish passage previously found at a site.	The Project is unlikely to reduce the extent, frequency or duration of fish passage because: ▪ waterway (including diversion channel) crossings would be constructed with consideration to the *Accepted Development Requirements for Operational Work that is Constructing or Raising Waterway Barrier Works* (DAF 2017), so as not to create a barrier to fish movement; and ▪ the diversion of Roper Creek would be sensitively designed to replicate natural features where possible and provide similar conditions to the original waterway, including stream hydraulics, geomorphology, instream habitat, bank profiles and bank vegetation, to provide habitat and refuge for fish inhabiting or passing through the diversion of Roper Creek. Further, the Surface Water Assessment (WRM 2020) concludes that the loss of catchment flows due to the Project in Roper Creek would be indiscernible.
Substantially modify, destroy or fragment areas of fish habitat (including, but not limited to in-stream vegetation, snags and woody debris, substrate, bank or riffle formations)	Roper Creek (mapped as 'Major risk' of impact on fish movement) would be diverted to the south of its existing alignment to allow for mining operations in this area (Figure 2). This diversion is unlikely to result in a significant impact to fish passage given the proposed diversion would be sensitively

Criteria	Assessment / consideration
necessary for the breeding and/or survival of fish.	designed to replicate natural features where possible and to simulate aquatic habitat attributes of the affected reach of Roper Creek and allow the free passage of fish both upstream and downstream in a safe manner.
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.	Surface water hydrology would be slightly altered by the Project as a result of capturing water in dams, water loss due to use for Project operation or pond evaporation, and releasing water during flow events. The volume, depth, timing, duration and frequency of flows would continue to reflect the ephemeral and variable flow nature of Roper Creek. The seasonality of fish movements is unlikely to be affected.
Lead to significant changes in water quality parameters such as temperature, dissolved oxygen, pH and conductivity that provide cues to movement in local fish species.	The Project is unlikely to lead to an abrupt or otherwise significant change in water quality parameters that would be expected to cue local fish movement. Any water releases required by the Project would continue to be managed in accordance with the EA Conditions (DES 2019f). The risk of deteriorating water quality would be mitigated by monitoring stream and release water quality and quantity in accordance with the EA.

6 MITIGATION MEASURES

Consistent with DES' management hierarchy, the mitigation strategy for the Project has focused on a hierarchy of:

1. avoidance;
2. minimisation;
3. mitigation; then
4. offset residual impacts.

The avoidance or minimisation of adverse impacts is most relevant to the design phase of the Project, where information collected through desktop analysis and field surveys can be incorporated into the planning and preliminary engineering work (Section 6.1). Mitigation of impacts (including the implementation of monitoring and management plans) is most relevant to the construction and operational phases of the Project. Table 24 provides a summary of the mitigation strategies for the Project, with a brief description of potential impacts and measures that can be implemented at each stage in the life of the Project.

No offset requirements relevant to aquatic ecology have been identified for the Project.

6.1 Measures to avoid and minimise impacts

The following measures would be implemented to avoid and / or minimise impacts on aquatic ecology:

- The Conceptual Southern Extension Footprint (Figure 2) incorporates sufficient area for a meandering diversion of Roper Creek within the ML to replicate natural features and provide similar conditions to the original waterway, including stream hydraulics, geomorphology, instream habitat, bank profiles and bank vegetation.
- The location of the mine and pits are informed by geological surveys and largely determined by the location of the natural resource, as a result the location of mine impacts are relatively inflexible. The Roper Creek diversion, however, has been avoided in the mine design and a minimum buffer of 200 m between the open cut pit extension and the Roper Creek diversion (defined bank) has been implemented.

6.2 Impact mitigation

Mitigation measures proposed to be implemented for the Project are detailed in Table 24.

Table 24 Mitigation measures

Potential impact	Mitigation measures
1. Aquatic habitat clearing	▪ Clearing of native vegetation undertaken progressively over the life of the mine and only in areas required for mining activities within the following year. This would have the effect of minimising the area of exposed land. ▪ The diversion of Roper Creek would be designed to replicate natural features where possible and provide similar conditions to the original waterway. ▪ Implement a Diversion Monitoring Program for Roper Creek, including: – monitoring of bed conditions following flow events; and – measures to monitor the success of the diversion channel design and construction, including post-construction survey of aquatic and riparian vegetation composition to demonstrate that effective cover has been achieved. ▪ Use of existing infrastructure and facilities to avoid the need for additional clearance works. ▪ Update and implement the Environmental Management Plan (EMP) (MCPL 2018) to include vegetation management measures, including: – demarcate exclusion zones to protect areas of vegetation to be retained prior to clearing; and – clearing of native vegetation to be undertaken progressively. ▪ Implement the Erosion and Sediment Control Plan (WRM 2019a), and: – where possible, construction works to be undertaken in the drier months of the year when rainfall and runoff is less likely. ▪ Update and implement the EMP (MCPL 2018) to include fauna species management measures, including: – use of suitable fauna spotter-catchers for relocation of animals, including any native fish isolated in the original channel when commissioning the Roper Creek diversion channel; – habitat retention and replacement, where possible; and – salvage of microhabitat features (e.g. boulders and logs) from the impacted reach of Roper Creek for use in the Roper Creek diversion channel. ▪ Temporarily clearing native vegetation, excavating, or placing fill in a watercourse necessary for and associated with mining operations would be undertaken in accordance with DNRM's (2012) *Guideline – Activities in a Watercourse, Lake or Spring Associated with Mining Operations*.
2. Removal of fish passage	▪ Design and construct waterway (including diversion channel) crossings with consideration to the *Accepted Development Requirements for Operational Work that is Constructing or Raising Waterway Barrier Works* (DAF 2017).
3. Alteration to surface water quality and / or quantity	▪ Controlled release of treated water from sediment dams (designed in accordance with the Best Practice Erosion and Sediment Control [IECAA 2008]) to the downstream environment would only occur in accordance with the EA conditions which is unlikely to have a measurable impact on receiving water quality. ▪ Continued monitoring of surface water quality for receiving water to be undertaken in accordance with the EA. ▪ Implement the Receiving Environment Monitoring Program (DPM Enviros ciences 2019).

Potential impact	Mitigation measures
	▪ Implement the Water Management Plan (WRM 2019b).
4. Surface runoff and sedimentation	▪ Installation of permanent drainage waste rock emplacement areas to minimise capture of surface runoff into the final voids and areas rehabilitated allowed to drain back to Roper Creek. ▪ Implementation of sediment dams to capture runoff. ▪ Sediment dam monitoring to be undertaken to validate the anticipated quality of water runoff to sediment dams.
5. Inundation	▪ Changes to the existing flood protection levee to prevent inundation of the open cut throughout the life of the project.
6. Alteration to groundwater quality	▪ Coal rejects continuously placed with overburden in the open cut pits and progressively rehabilitated during mining to minimise and mitigate generation of acid over time. ▪ A groundwater monitoring network has been established which includes groundwater level and quality monitoring locations within and surrounding the mine site, in accordance with the EA.
7. Chemical contamination	▪ All chemicals would be transported, handled and stored in accordance with relevant Australians Standards. The controls that will be implemented represent standard practice and a legislated requirement at mine sites for preventing the contamination.
8. Pest invasions (flora and fauna)	▪ Restrict or reduce existing infestations. ▪ Avoid introduction of new weeds to the Project area. ▪ Update and implement the EMP (MCPL 2018) to include pest management measures.

7 CONCLUSION

The scope of this assessment was to describe the aquatic values, identify any conservation significant aquatic species under the NC Act and EPBC Act, to identify the presence of surface expression or subterranean GDEs, identify and describe any MSES and MNES; and to identify proposed impact avoidance and mitigation measures to protect natural values.

Aquatic ecology surveys were undertaken in accordance with the AusRivAS protocols for Queensland streams. In addition, the Queensland *Guideline for the Environmental Assessment of Subterranean Aquatic Fauna* (DSITI 2015) and the *Information Guidelines Explanatory Note: Assessing groundwater-dependent ecosystems* (Doody et al. 2019) were applied and a desktop review was undertaken to assist in determining the likelihood and significance of surface expression and subterranean GDEs potentially occurring within the Study area. The assessment of subterranean GDEs was supplemented by sampling of 11 representative bores in October 2019 and 10 representative bores in February 2020.

The waterways of the Project area are ephemeral and experience flow only after sustained or intense rainfall and runoff in the catchment. The streambed of Roper Creek is comprised of unconsolidated (loosely arranged and unpacked) sands and silts forming a relatively flat stream bed void of pool or riffle sequences. The transient flow, lack of pools and lack of dry season refuge limits the ability of Roper Creek to provide sustained habitat for native fish and turtles. Thirteen Mile Gully has a smaller catchment, although a more consolidated silt and clay stream bed, providing a more natural channel profile. Following a flow event, wetted habitat is likely to persist in pools located on Thirteen Mile Gully for longer duration than Roper Creek. Roper Creek and Thirteen Mile Gully may provide temporary foraging habitat for common (Least Concern) native fish and turtle species, and limited breeding habitat for native fishes adapted to these transient flow conditions.

Waterways providing for fish passage are a MSES only if the construction, installation or modification of waterway barrier works will limit the passage of fish along the waterway. As part of the Project, Roper Creek Diversion 2 (an approved diversion) would need to be realigned to allow for the southern extension of the open cut within ML 70379. A diversion is proposed for Roper Creek to maintain its ecological function, including for fish habitat and passage. The diversion would be constructed and commissioned prior to impacting the affected reach of Roper Creek. Consequently, the Project is not expected to result in a significant impact on fish passage. Other potentially relevant MSES are addressed in the terrestrial ecology assessment.

There are no wetlands of International Importance, National Importance or High Ecological Significance within the Study area. No conservation significant aquatic flora or fauna species listed under the NC Act and / or EPBC Act were recorded within the Study area, nor are they expected to occur considering their required habitats are not present. In addition, no MNES relevant to aquatic ecology were identified.

Field surveys in October 2019 and February 2020 found no evidence of river-base flow systems or groundwater-fed wetlands in the Study Area. No potential surface GDEs are mapped in the Queensland GDE mapping (DES 2019c) for the Study area, nor are they likely to occur. Quaternary alluvium is distributed within the Middlemount Coal Mine from Roper Creek in the south to Thirteen Mile Gully in the north, and is comprised of clay, silt and sand (AGE 2018). Where it occurs, the alluvium is thin, usually less than 5 m (Parsons Brinkerhoff 2010, cited in AGE 2020). Groundwater levels at the site are typically below the base of the alluvium, indicating that the alluvium is typically unsaturated (AGE 2018).

No stygofauna were detected in a pilot survey conducted within and surrounding the Study area in October 2019 and February 2020. It is unlikely that subterranean GDEs occur within the Study area. The Study area is already subject to groundwater impacts and its aquifers are unlikely to represent particularly natural or unique habitat for stygofauna that doesn't otherwise occur in the broader area. Accordingly, in the unlikely event that subterranean GDEs do occur in the Study area or surrounds, they would be attributed a low ecological value. Further, any impacts would be insignificant when placed in the context of the wider extent of similar habitat.

Indirect impacts that have been considered in this assessment include potential impacts associated with changes in water quality, hydrological changes, impacts to groundwater dependant ecosystems and potential cumulative impacts. It is concluded that the Project is unlikely to have a significant impact on aquatic ecology as a result of these potential indirect impacts.

In conclusion, the Project is unlikely to result in a significant impact on any MNES or MSES, including conservation significant aquatic species listed under the NC Act and EPBC Act, aquatic ecological communities or their habitats.

REFERENCES

4T 2012, *Desktop assessment of likelihood of stygofauna occurrence in the Bowen Basin*. Report to URS Australia Pty Ltd, https://www.arrowenergy.com.au/Operations/project-assessment-eis/bowen-gas-project-eis (Appendix EE)

Allen GR, Midgley SH and Allen M 2002, *Field guide to the freshwater fishes of Australia*, Western Australia Museum.

Atlas of Living Australia (ALA) 2020, *Australia's species*, http://bie.ala.org.au

Australasian Groundwater and Environmental Consultants (AGE) 2018, *Middlemount Coal Mine Western Extension Project: Groundwater Assessment.* Prepared for Middlemount Coal Pty Ltd.

Australasian Groundwater and Environmental Consultants (AGE) 2020*, Middlemount Coal Mine Southern Extension Project: Groundwater Assessment*. Prepared for Middlemount Coal Pty Ltd.

Boulton, Andrew J., and Brock, Margaret A. 1999, *Australian freshwater ecology: processes and management*. Gleneagles Publishing, Glen Osmond, S. Aust.

Bradford, M.G, Kroon, F.J, and Russell, D.J., 2011, *The biology and management of Tilapia mariae (Pisces: Cichlidae) as a native and invasive species: a review.* Marine and Freshwater Research 62, 902-917.

Bureau of Meteorology (BoM) 2019, Booroondarra Station 35109 monthly rainfall data, http://www.bom.gov.au/jsp/ncc/cdio/weatherData/av?p_nccObsCode=136&p_display_type=dailyDataFile&p_startYear=&p_c=&p_stn_num=035109, accessed 5 June 2019.

Catchment Solutions 2015, *Preliminary investigation into the distribution of Tilapia in the upper Fitzroy Catchment*. Catchment Solutions Pty Ltd. Mackay

Chessman, Bruce C. 2003, *New sensitivity grades for Australian river macroinvertebrates,* accessed August 2020, available: https://www.mdfrc.org.au/bugguide/resources/Chessman2003.pdf

Clayton PD, Fielder DP, Howell S and Hill CJ 2006, *Aquatic Biodiversity Assessment and Mapping Method (AquaBAMM): a conservation values assessment tool for wetlands with trial application in the Burnett River catchment.* Environmental Protection Agency, Brisbane.

Cogger HG 2014, *Reptiles and Amphibians of Australia (Seventh Edition)*. CSIRO Publishing, Collingwood.

Coughran J and Furse JM 2010, *An assessment of genus Eustacus (49 species) versus IUCN Red List criteria*. International Association of Astacology, USA.

Council of Heads of Australasian Herbaria (CHAH) 2014, *Australian Plant Name Index. Integrated Biodiversity Information System, Australian National Botanic Gardens, Australian National Herbarium*, viewed 8 January 2020*, http://www.cpbr.gov.au/cpbr/databases/apni-search-full.html*

Department of Agriculture and Fisheries (DAF) 2019, Mapping data – *Queensland Waterways for Waterway Barrier Works 2016*, Version 10.0. Queensland Government, Brisbane.

Department of Agriculture and Fisheries (DAF) 2017, *Accepted Development Requirements for Operational Work that is Constructing or Raising Waterway Barrier Works.* Queensland Government, Brisbane.

Department of Agriculture, Fisheries and Forestry (DAFF) 2012, *Interpretation of water analysis for irrigation*. Queensland Government, Brisbane.

Department of Agriculture, Fisheries and Forestry (DAFF) 2013, *Guide for the determination of waterways using the spatial data layer Queensland waterways for waterway barrier works*. Queensland Government, Brisbane.

Department of Environment and Energy (DEE) 2019, *EPBC Act Protected Matters Report*, created 26 September 2019, http://environment.gov.au/epbc/protected-matters-search-tool

Department of Environment and Energy (DEE) 2020a, *Protected Matters Search Tool – Interactive Map Tool*, accessed 8 January 2020, http://environment.gov.au/epbc/protected-matters-search-tool

Department of Environment and Energy (DEE) 2020b, *Species Profile and Threats Database*, accessed 8 January 2020, http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=1761

Department of Environment and Energy (DEE) 2020c, *Weeds in Australia*, accessed 20 April 2018, http://www.environment.gov.au/biodiversity/invasive/weeds/weeds/lists/wons.html

Department of Environment and Heritage Protection (DEHP) 2009, *Monitoring and Sampling Manual 2009,* Version 2, July 2013. Queensland Government.

Department of Environment and Heritage Protection (DEHP) 2011, *Environmental Protection (Water) Policy 2009: Mackenzie River Sub-basin Environmental Values and Water Quality Objectives Basin No. 130 (part), including all waters of the Isaac River Sub-basin (including Connors River)*. Queensland Government, Brisbane.

Department of Environment and Heritage Protection (DEHP) 2014, *Queensland Environmental Offsets Policy: Significant Residual Impact Guideline*. DEHP, Brisbane.Department of Environment and Resource Management (DERM) 2010, *Fitzroy Natural Resource Management Bioregion Back on Track Actions for Biodiversity*. Queensland Government, Brisbane.

Department of Environment and Science (DES) 2018, *Monitoring and Sampling Manual: Environmental Protection (Water) Policy*. Brisbane: Department of Environment and Science Government.

Department of Environment and Science (DES) 2019a, Mapping data – *Matters of State Environmental Significance*. Queensland Government, Brisbane.

Department of Environment and Science (DES) 2019b, Mapping data – *Queensland Wetland Data Version 5 – Queensland Wetlands Map*. Queensland Government, Brisbane.

Department of Environment and Science (DES) 2019c, Mapping data – *Queensland Groundwater Dependent Ecosystems and Potential GDE Aquifer Mapping 2018 Version 1.5.1*. Queensland Government, Brisbane.

Department of Environment and Science (DES) 2019d, *Map of Great Barrier Reef Wetland Protection Areas*, accessed 4 December 2019, available: https://environment.des.qld.gov.au/wildlife/wetlands/map-referrable-wetlands/request-form/_nocache

Department of Environment and Science (DES) 2019e, *Map of Queensland Wetland Environmental Values*, accessed 4 December 2019, available: https://environment.des.qld.gov.au/wildlife/wetlands/map-referrable-wetlands/request-form/_nocache

Department of Environment and Science (DES) 2019f, Environmental Authority (Mining Activities) – Mining Project Permit Number EPML00716913 – Middlemount Coal Mine. Issued under Chapter 5 of the *Environmental Protection Act 1994*, effective 21 March 2019. DES, Brisbane.

Department of Environment and Science (DES) 2020a, Wetland*Info – Fitzroy Basin*, viewed 8 January 2020, available: https://wetlandinfo.ehp.qld.gov.au/wetlands/facts-maps/basin-fitzroy/

Department of Environment and Science (DES) 2020b, *Myriophyllum artesium, WetlandInfo*, viewed 8 January 2020, available: http://wetlandinfo.ehp.qld.gov.au/wetlands/ecology/components/species/?myriophyllum-artesium

Department of Environment and Science (DES) 2020c, *Phaius australis, WetlandInfo*, viewed 8 January 2020, available: http://wetlandinfo.ehp.qld.gov.au/wetlands/ecology/components/species/?phaius-australis

Department of Environment and Science (DES) 2020d, *Thelypteris confluens, WetlandInfo*, viewed 8 January 2020, available: https://wetlandinfo.ehp.qld.gov.au/wetlands/ecology/components/species/?thelypteris-confluens

Department of Environment and Science (DES) 2020e, *Aponogeton queenslandicus, WetlandInfo*, viewed 8 January 2020, available: https://wetlandinfo.ehp.qld.gov.au/wetlands/ecology/components/species/?aponogeton-queenslandicus

Department of Environment and Science (DES) 2020f, *Eleocharis blakeana, WetlandInfo*, viewed 8 January 2020, available: https://wetlandinfo.ehp.qld.gov.au/wetlands/ecology/components/species/?eleocharis-blakeana

Department of Environment and Science (DES) 2020g, *White-throated snapping turtle,* viewed 8 January 2020, available: https://www.des.qld.gov.au/wildlife/animals-az/whitethroated_snapping_turtle.html

Department of Natural Resources and Mines (DNRM) 2001, *Queensland Australian River Assessment System (AusRivAS) Sampling and Processing Manual. Queensland Government, Rocklea.*

Department of Natural Resources and Mines (DNRM) 2012, *Guideline – Activities in a watercourse, lake or spring associated with a resource activity or mining operations WAM/2008/3435*. Queensland Government, Brisbane.

Department of Natural Resources, Mines and Energy (DNRME) 2019, *Watercourse Identification Map (WIM) under the Water Act 2000, Version 6.13*. DNRM, Brisbane.

Department of Natural Resources, Mines and Energy (DNRME) 2020, Mapping data – *Detailed Surface Geology of Queensland*. Queensland Government, Brisbane.

Department of Sustainability, Environment, Water, Population and Communities (DSEWPC) 2011, *Survey Guidelines for Australia's Threatened Reptiles*, viewed 8 January 2020.

Department of Science, Information Technology and Innovation (DSITI) 2015, *Guideline for the Environmental Assessment of Subterranean Aquatic Fauna*. Queensland Government, Brisbane.

Doody TM, Hancock PJ and Pritchard JL 2019, *Information Guidelines Explanatory Note: Assessing groundwater-dependent ecosystems*. Report prepared for the Independent Expert Scientific Committee on Coal Seam Gas and Large Coal Mining Development through the Department of the Environment and Energy, Commonwealth of Australia 2019.

DPM Enviroscences 2018, *Olive Downs Coking Coal Project Aquatic Ecology Assessment*.

DPM Enviroscences 2019, *Middlemount Coal Mine Receiving Environment Monitoring Program – Design Document*.

DPM Enviroscences 2020, *BMA Blackwater Mine Baseline Aquatic Ecology Survey*.

Eyre TJ, Ferguson DJ, Hourigan CL, Smith GC, Mathieson MT, Kelly AL, Venz MF, Hogan LD and Rowland J 2014, *Terrestrial Vertebrate Fauna Survey Assessment Guidelines for Queensland,* Department of Science, Information Technology, Innovation and the Arts (DSITIA), Queensland Government, Brisbane.

Fielder D, Davidson W and Barratt P 2011, *Aquatic Conservation Assessments (ACA), using AquaBAMM, for the wetlands of the Queensland Murray–Darling Basin*. Department of Environment and Resource Management, Brisbane.

FRC Environmental 2010, *Middlemount Coal Project EIS, Stage 2: Aquatic Ecology*. Prepared for Middlemount Coal Pty Ltd.

GHD 2013, *Middlemount Stygofauna Pilot Study Data Report*, prepared for Middlemount Coal Pty Ltd.

GHD 2019, *Middlemount Coal REMP 2019 monitoring report*, prepared for Middlemount Coal Pty Ltd.

Halford D 1996, *Eleocharis blakeana, in Species Management Manual*. Department of Natural Resources, Brisbane. Hansen Bailey 2009, Eagle Downs Project – Flora and Fauna Impact Assessment. Bowen Central Coal Management Pty Ltd.

Halse SA and Pearson GB 2014, *Troglofauna in the vadose zone: comparison of scraping and trapping results and sampling adequacy*, *Subterranean Biology*, 13: 17-34.

Harden GJ 2002, *Flora of New South Wales – Volume 2*, University of New South Wales, Sydney.

Independent Expert Scientific Committee (IESC) 2018, *Assessing Groundwater-Dependent Ecosystems: IESC Information Guidelines Explanatory Note*.

Inglis SN and Howell S 2009, Aquatic Conservation Assessments for the riverine wetlands of the Great Barrier Reef Catchment: Fitzroy region. Department of Environment and Resource Management, Queensland Government.

International Erosion Control Association Australasia (IECAA) 2008, *Best Practice Erosion and Sediment Control guideline.*

James CS, Thoms MC and Quinn GP 2008, *Zooplankton dynamics from inundation to drying in a complex ephemeral floodplain-wetland,* Aquatic Sciences, 70: 259-271.

Lintermans M 2007, *Fishes of the Murray-Darling Basin: An introductory guide*. Murray-Darling Basin Authority, Publication No. 10/07, Canberra ACT.

Marshall C, Harch BD, Choy SC, Smith MJ 2001, Design and Implementation of Baseline Monitoring (DIBM3), Chapter 8: Aquatic macroinvertebrates as indicators of ecosystem health.

Melzer R and Plumb J 2011, *Plants of Capricornia*. Belgamba, Rockhampton.

Middlemount Coal Limited (MCPL) 2018, *Environmental Management Plan (Management Plan 003)*.NSW Department of Primary Industries (NSW DPI) 2017, *Pests and diseases: Tilapia*, viewed 8 January 2020, http://www.dpi.nsw.gov.au/fishing/pests-diseases/freshwater-pests/species/tilapia

Peterken C, Ringwood G and Sarac Z 2009, *Waterway barrier works development approvals*, Queensland Primary Industries and Fisheries Fish Habitat Management Operational Policy FHMOP 008.

Pusey BJ, Kennard MJ and Arthington AH 2004, *Freshwater fishes of north-eastern Australia*, CSIRO Publishing, Collingwood, Victoria.

Resource Strategies Pty Ltd (Resource Strategies) 2018, *Middlemount Coal Mine Western Extension Project Environmental Assessment Report*. Prepared for Middlemount Coal Pty Ltd.

Rollason SN and Howell S 2012, *Aquatic Conservation Assessments (ACA), using AquaBAMM, for the non-riverine wetlands of the Great Barrier Reef catchment,* Version 1.3. Published by the Department of Environment and Resource Management, Brisbane.

Romanowski N 1998, *Aquatic and wetland plants: a field guide for non-tropical Australia*. University of New South Wales Press Ltd, Sydney.

Sainty GR and Jacobs SWL 2003, *Waterplants in Australia*, Sainty and Associates Pty Ltd, NSW.

Serov P, Kuginis L and Williams JP 2012, *Risk assessment guidelines for groundwater dependent ecosystems, Volume 1 – The conceptual framework*, NSW Department of Primary Industries, Office of Water, Sydney.

Stanley TD and Ross EM 1983, *Flora of south-eastern Queensland*. Queensland Department of Primary Industries, Brisbane.

Stephens KM and Dowling RM 2002, *Wetland plants of Queensland*. CSIRO, Collingswood, Victoria.

Todd EV, Blair D, Farley S, Farrington L, Fitzsimmons NN, Georges A, Limpus CJ and Jerry DR 2013, *'Contemporary genetic structure reflects historical drainage isolation in an Australian snapping turtle, Elseya albagula', Zoological Journal of the Linnean Society*, vol. 169, pp. 200-214.

Wilson, K.L. 2006 *Eleocharis blakeana, in PlantNet: New South Wales Flora Online*. National Herbarium of New South Wales. Accessed 8 January 2020. Available: http://plantnet.rbgsyd.nsw.gov.au/

WRM 2019a, *Middlemount Coal Mine Erosion and Sediment Control Plan*.

WRM 2019b, *Middlemount Coal Mine Water Management Plan.*

WRM 2020, *Middlemount Coal Mine Southern Extension Project Surface Water Impact Assessment.*

Appendix A: EPBC Act Protected Matters Report

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.

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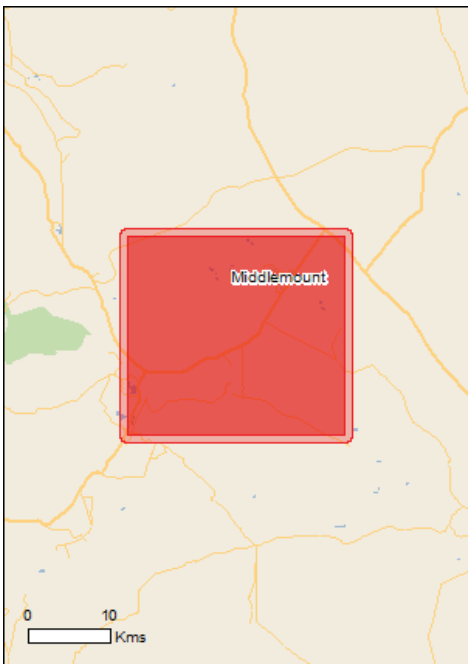

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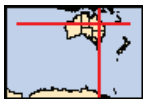

Summary

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:	3
Listed Threatened Species:	24
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:	None
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:	None
Regional Forest Agreements:	None
Invasive Species:	16
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
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

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 may occur within area
Mammals		
Chalinolobus dwyeri Large-eared Pied Bat, Large Pied Bat [183]	Vulnerable	Species or species habitat may occur within area
Dasyurus hallucatus Northern Quoll, Digul [Gogo-Yimidir], Wijingadda [Dambimangari], Wiminji [Martu] [331]	Endangered	Species or species habitat may occur within area
Macroderma gigas Ghost Bat [174]	Vulnerable	Species or species

Name	Status	Type of Presence
		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 known 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 known to occur within area
Pteropus poliocephalus Grey-headed Flying-fox [186]	Vulnerable	Roosting known to occur within area
Plants		
Cadellia pentastylis Ooline [9828]	Vulnerable	Species or species habitat likely 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 likely to occur within area
Reptiles		
Delma torquata Adorned Delma, Collared Delma [1656]	Vulnerable	Species or species habitat may 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 habitat may occur within area
Elseya albagula Southern Snapping Turtle, White-throated Snapping Turtle [81648]	Critically Endangered	Species or species habitat likely to occur within area
Furina dunmalli Dunmall's Snake [59254]	Vulnerable	Species or species habitat may occur within area
Lerista allanae Allan's Lerista, Retro Slider [1378]	Endangered	Species or species habitat may 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

Name	Threatened	Type of Presence
		area
Monarcha melanopsis Black-faced Monarch [609]		Species or species habitat known 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 may 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

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 known to occur within area
Ardea ibis Cattle Egret [59542]		Species or species habitat may occur within

Name	Threatened	Type of Presence
		area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat may 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 may 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 known 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
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 may occur within area

Extra Information

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

Name	Status	Type of Presence
Passer domesticus House Sparrow [405]		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
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
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
Jatropha gossypifolia Cotton-leaved Physic-Nut, Bellyache Bush, Cotton-leaf Physic Nut, Cotton-leaf Jatropha, Black Physic Nut [7507]		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

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

-22.77294 148.53829,-22.77294 148.77362,-22.97187 148.77362,-22.97187 148.53829,-22.77294 148.53829

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: Aquatic Survey Site Profiles

Season: Dry

Site Code: R1 **Location:** Roper Creek **Stream order:** 4 **Latitude:** -22.8758 **Longitude:** 148.6715 **Date:** 14/10/2019


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; some local catchment erosion (gullying); infilled channel as a result of extensive sand deposition; bank shape convex; banks moderately stable; vegetative stability excellent; bankfull width approx. 30 m and bankfull height approx. 5 m; lacking in-stream habitat features; bed substrates comprised approximately 1% pebble (4-64 mm), 4% gravel (2-4 mm) and 95% sand (0.05-2 mm); upstream landuse includes coal mining and cattle grazing in partly cleared, partly remnant vegetation; adjacent land previously grazed, but no evidence of current grazing.

Aquatic and riparian vegetation

Study reach positioned within riparian woodland State-mapped as non-remnant; riparian zone approximately 20 m on the left bank and 20 m on the right, with sparse woodland dominated by Queensland blue gum (*Eucalyptus tereticornis*), with abundant river oak (*Casuarina cunninghamiana*); adjoining plain dominated by poplar box (*Eucalyptus populnea*); very sparse shrub layer, including wilga (*Geijera parviflora*), dead finish (*Archidendropsis basaltica*), currant bush (*Carissa ovata*) and velvet tree pear (*Opunita tomentosa*)*; ground layer of upper bank dominated by buffel grasss (*Cenchrus ciliaris*)*, with occasional kangaroo grass (*Themeda triandra*), *Sida* sp. and black spear grass (*Heteropogon contortus*); ground layer of lower bank dominated by common couch (*Cynodon dactylon*) and speargrass (*Heteropogon* sp.), with frequent spiny-head mat-rush (*Lomandra longifolia*), occasional kangaroo grass, bluegrass (*Bothriochloa* sp.), lesser joyweed (*Alternanthera denticulata*), *Sporobolous* sp. and Mexican poppy (*Argemone ochroleuca*)*; semi-aquatic macrophytes included little (1-10%) tall flatsedge (*Cyperus exaltatus*).

Erosion risk

Moderate – Banks appeared to be moderately stable, and with >80% of streambank surfaces covered by vegetation or tree roots.

Aquatic fauna, including breeding habitat

No aquatic fauna detected. May provide suitable foraging habitat for fish in times of flow. No fish, turtle or platypus breeding habitat detected.

Endangered, Vulnerable, Near Threatened (EVNT) or Special Least Concern (SLC) flora and fauna

No EVNT or SLC 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 2019). However, the study reach is unlikely to provide suitable habitat for these species.

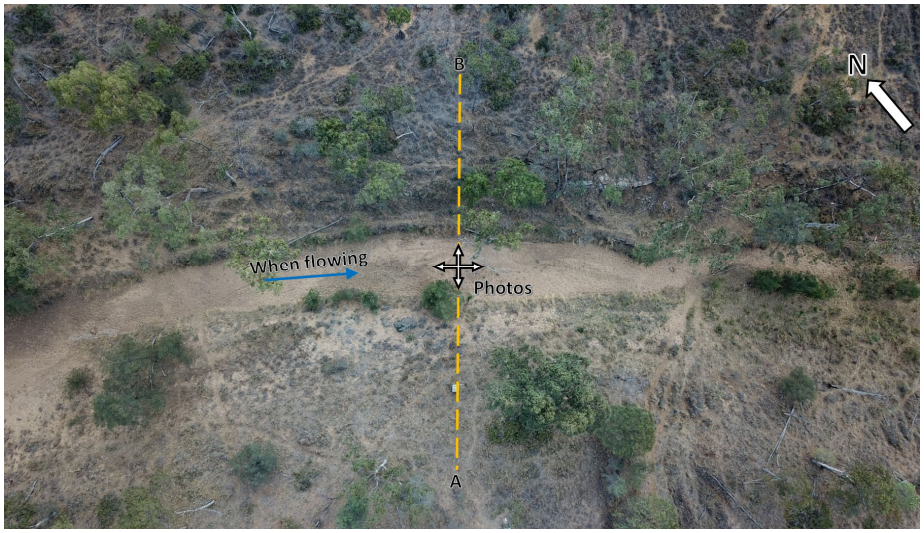
Physico-chemical water quality

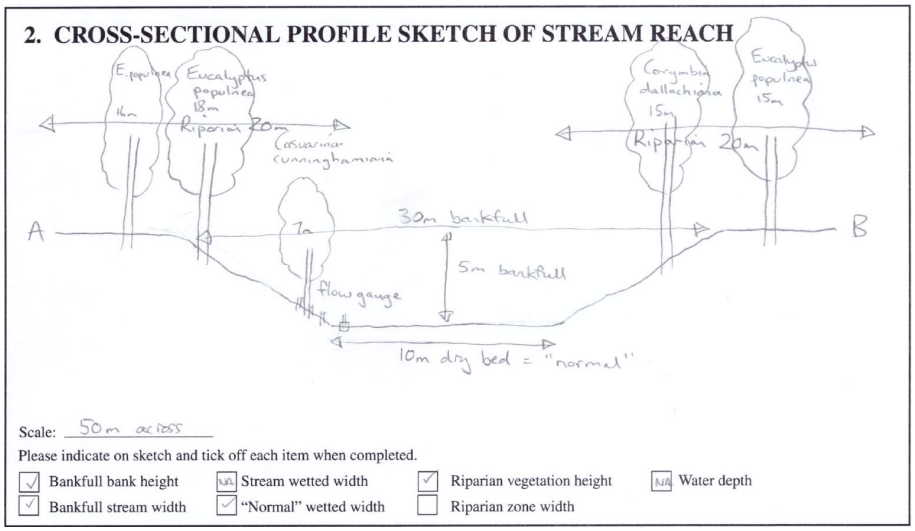
Dry at the time of assessment.

Bioassessment scores

Habitat assessment score for dry season: Poor (33).

Overall aquatic values – Dry season: **Moderate**.





Season: Wet

Site Code: R1 **Location:** Roper Creek **Stream order:** 4 **Latitude:** -22.8758 **Longitude:** 148.6715 **Date:** 18/02/2020

Upstream

Left Bank

Downstream

Right Bank

General Site Description

Site attributes

Ephemeral fourth order drainage line; isolated shallow pools at the time of assessment; well defined bed and banks; some local catchment erosion (gullying); infilled channel as a result of extensive sand deposition; bank shape convex; banks moderately stable; vegetative stability excellent; bankfull width approx. 30 m and bankfull height approx. 5 m; in-stream habitat features included shallow (<0.5 m deep) pools; bed substrates comprised approximately 1% pebble (4-64 mm), 4% gravel (2-4 mm) and 95% sand (0.05-2 mm); upstream landuse includes coal mining and cattle grazing in partly cleared, partly remnant vegetation; adjacent land previously grazed, but no evidence of current grazing.

Aquatic and riparian vegetation

Study reach positioned within riparian woodland State-mapped as non-remnant; riparian zone approximately 20 m on the left bank and 20 m on the right, with sparse woodland dominated by Queensland blue gum (*Eucalyptus tereticornis*), with abundant river oak (*Casuarina cunninghamiana*); adjoining plain dominated by poplar box (*Eucalyptus populnea*); very sparse shrub layer, including wilga (*Geijera parviflora*), dead finish (*Archidendropsis basaltica*), currant bush (*Carissa ovata*) and velvet tree pear (*Opunita tomentosa*)*; ground layer of upper bank dominated by buffel grasss (*Cenchrus ciliaris*)*, with occasional kangaroo grass (*Themeda triandra*), *Sida* sp. and black spear grass (*Heteropogon contortus*); ground layer of lower bank dominated by green panic (*Megathyrsus maximus*)* and common couch (*Cynodon dactylon*), with frequent blady grass (*Imperata cylindrica*), speargrass (*Heteropogon* sp.) and spiny-head mat-rush (*Lomandra longifolia*), occasional kangaroo grass, bluegrass (*Bothriochloa* sp.), lesser joyweed (*Alternanthera denticulata*), *Sporobolous* sp. and poison pratia (*Pratia concolor*); semi-aquatic macrophytes included little (1-10%) *Cyperus victoriensis*, tall flatsedge (*Cyperus exaltatus*) and white eclipta (*Eclipta prostrata*)*.

Erosion risk

Moderate – Banks appeared to be moderately stable, and with >80% of streambank surfaces covered by vegetation or tree roots.

Aquatic fauna, including breeding habitat

The reach provides foraging habitat for fish. Unlikely foraging habitat for turtles or platypus. Unlikely breeding habitat for fish, turtles or platypus. Aquatic vertebrate fauna detected by backpack electrofishing and overnight deployment of two baited fyke nets and five baited box traps included juvenile spangled perch (*Leiopotherpon unicolor*), eastern rainbowfish (*Melanotaenia splendida*) and Hyrtl's tandan (*Neosilurus hyrtlii*).

Endangered, Vulnerable, Near Threatened (EVNT) or Special Least Concern (SLC) flora and fauna

No EVNT or SLC 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 2019). However, the study reach is unlikely to provide suitable habitat for these species.

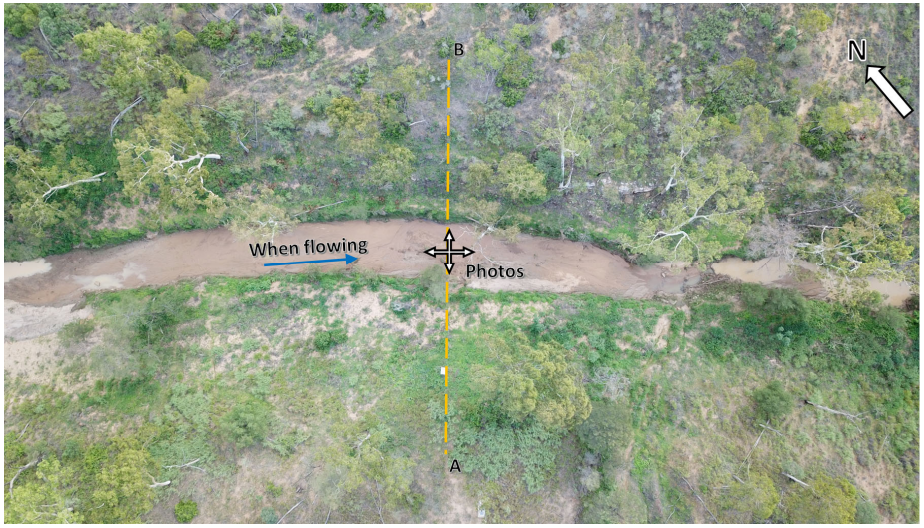
Physico-chemical water quality

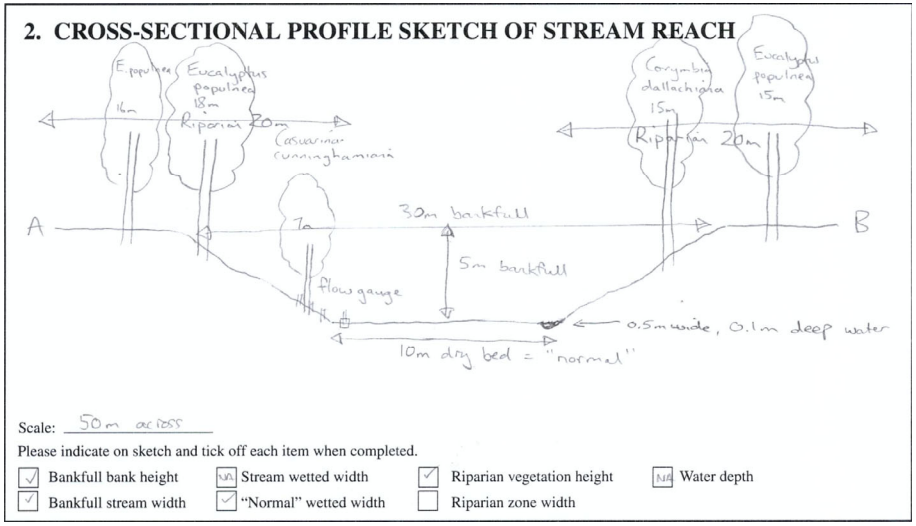
Collection time: 07:55; water temp.: 26.9˚C; specific conductivity: 290 µS/cm (fresh); turbidity: 390 NTU (poor clarity); dissolved oxygen: 51.9%, 4.1 mg/L (low, but typical for time of day); pH: 7.4 (mildly alkaline). Comments: Normal.

Bioassessment scores

Habitat assessment score for dry season: Fair (39).

Overall aquatic values – Wet season: **Moderate**.





Season: Dry

Site Code: R2 **Location:** Roper Creek **Stream order:** 4 **Latitude:** -22.8754 **Longitude:** 148.6575 **Date:** 14/10/2019

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; no local catchment erosion detected; infilled channel as a result of extensive sand deposition; bank shape convex; banks moderately stable; bank vegetative stability excellent; bankfull width approx. 80 m and bankfull height approx. 10 m; lacking in-stream habitat features; bed substrates comprised approximately 3% gravel (2-4 mm), 92% sand (0.05-2 mm) and 5% silt/clay (<0.05 mm); upstream landuse includes coal mining and cattle grazing in partly cleared, partly remnant vegetation; adjacent land previously grazed, but not current.

Aquatic and riparian vegetation

Study reach positioned within riparian woodland State-mapped as 11.3.25 – '*Eucalyptus tereticornis* or *E. camaldulensis* woodland fringing drainage lines'; riparian zone approximately 35 m on the left bank and 35 m on the right, dominated by Queensland blue gum (*Eucalyptus tereticornis*), with frequent river oak (*Casuarina cunninghamiana*), occasional carbeen (*Corymbia tessellaris*) and Dallachy's gum (*C. dallachiana*); adjoining plain dominated by poplar box (*E. populnea*); very sparse shrub layer, including whitewood (*Atalaya hemiglauca*), sally wattle (*Acacia salicina*), bean tree (*Cassia brewsteri*) and red bauhinia (*Lysiphyllum carronii*); ground layer of the upper bank dominated by buffel grasss (*Cenchrus ciliaris*)*, with frequent cobbler's pegs (*Bidens pilosa*)*, *Sida* sp. and shrubby stylo (*Stylosanthes scabra*)*; ground layer of the lower bank dominated by speargrass (*Heteropogon* sp.), with frequent spiny-head mat-rush (*Lomandra longifolia*) and bluegrass (*Bothriochloa* sp.); semi-aquatic macrophytes included little (1-10%) tall flatsedge (*Cyperus exaltatus*), willow primrose (*Ludwigia octovalvis*) and white eclipta (*Eclipta prostrata*)*.

Erosion risk

Low – Banks appeared to be moderately stable, and with >80% of streambank surfaces covered by vegetation or tree roots.

Aquatic fauna, including breeding habitat

No aquatic fauna detected. May provide suitable foraging habitat for fish in times of flow. No fish, turtle or platypus breeding habitat detected.

Endangered, Vulnerable, Near Threatened (EVNT) or Special Least Concern (SLC) flora and fauna

No EVNT or SLC 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 2019). However, the study reach is unlikely to provide suitable habitat for these species.

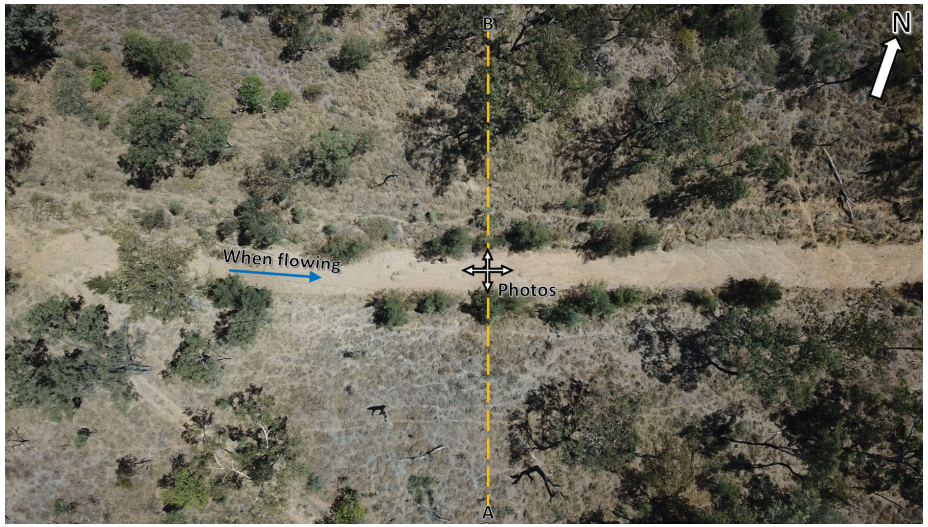
Physico-chemical water quality

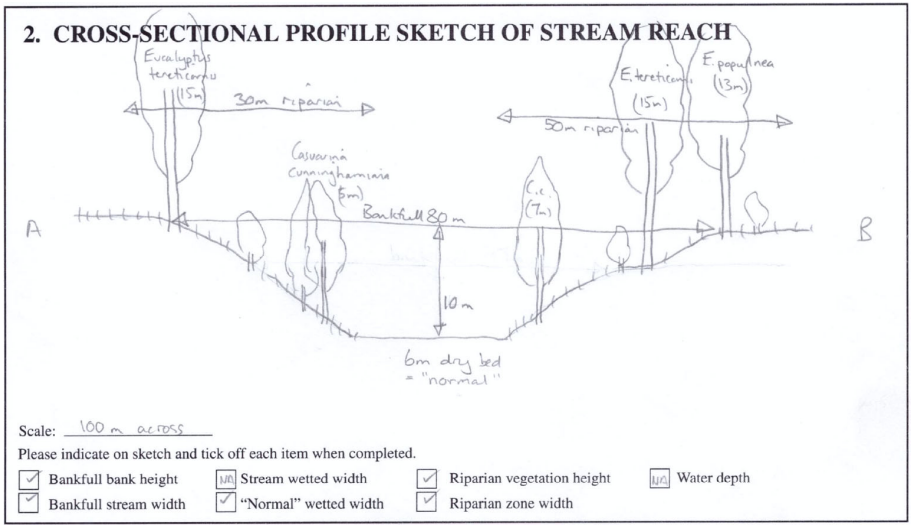
Dry at the time of assessment.

Bioassessment scores

Habitat assessment score for dry season: Poor (31).

Overall aquatic values – Dry season: **Moderate**.





Season: Dry

Site Code: R2 **Location:** Roper Creek **Stream order:** 4 **Latitude:** -22.8754 **Longitude:** 148.6575 **Date:** 19/02/2020


Upstream


Left Bank


Downstream


Right Bank

General Site Description

Site attributes

Ephemeral fourth order drainage line; isolated shallow pools at the time of assessment; well defined bed and banks; no local catchment erosion detected; infilled channel as a result of extensive sand deposition; bank shape convex; banks moderately stable; bank vegetative stability excellent; bankfull width approx. 80 m and bankfull height approx. 10 m; in-stream habitat features include shallow pools; bed substrates comprised approximately 3% gravel (2-4 mm), 92% sand (0.05-2 mm) and 5% silt/clay (<0.05 mm); upstream landuse includes coal mining and cattle grazing in partly cleared, partly remnant vegetation; adjacent land previously grazed, but not current.

Aquatic and riparian vegetation

Study reach positioned within riparian woodland State-mapped as 11.3.25 – '*Eucalyptus tereticornis* or *E. camaldulensis* woodland fringing drainage lines'; riparian zone approximately 35 m on the left bank and 35 m on the right, dominated by Queensland blue gum (*Eucalyptus tereticornis*), with frequent river oak (*Casuarina cunninghamiana*), occasional carbeen (*Corymbia tessellaris*) and Dallachy's gum (*C. dallachiana*); adjoining plain dominated by poplar box (*E. populnea*); very sparse shrub layer, including whitewood (*Atalaya hemiglauca*), sally wattle (*Acacia salicina*), bean tree (*Cassia brewsteri*), red bauhinia (*Lysiphyllum carronii*), castor oil plant (*Ricinus communis*)* and lantana (*Lantana camara*)*; ground layer of the upper bank dominated by green panic (*Megathyrsus maximus*)* and buffel grasss (*Cenchrus ciliaris*)*, with frequent cobbler's pegs (*Bidens pilosa*)*, *Sida* sp. and shrubby stylo (*Stylosanthes scabra*)*; ground layer of the lower bank dominated by green panic, with frequent spiny-head mat-rush (*Lomandra longifolia*), bluegrass (*Bothriochloa* sp.), and occasional speargrass (*Heteropogon* sp.), sneezeweed (*Centipeda minima*), lesser joyweed (*Alternanthera denticulata*), musk basil (*Basilicum polystachyon*) and poison pratia (*Pratia concolor*); semi-aquatic macrophytes included little (1-10%) *Cyperus victoriensis*, tall flatsedge (*C. exaltatus*), bunchy sedge (*C. polystachyos*), white eclipta (*Eclipta prostrata*)*, common rush (*Juncus usitatus*) and willow primrose (*Ludwigia octovalvis*).

Erosion risk

Low – Banks appeared to be moderately stable, and with >80% of streambank surfaces covered by vegetation or tree roots.

Aquatic fauna, including breeding habitat

The reach provides foraging habitat for fish. Unlikely foraging habitat for turtles or platypus. Unlikely breeding habitat for fish, turtles or platypus. Aquatic vertebrate fauna detected by backpack electrofishing and overnight deployment of two baited fyke nets and five baited box traps included juvenile spangled perch (*Leiopotherpon unicolor*). Three freshwater snakes / keelbacks (*Tropidonophis mairii*) also captured in fyke nets.

Endangered, Vulnerable, Near Threatened (EVNT) or Special Least Concern (SLC) flora and fauna

No EVNT or SLC 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 2019). However, the study reach is unlikely to provide suitable habitat for these species.

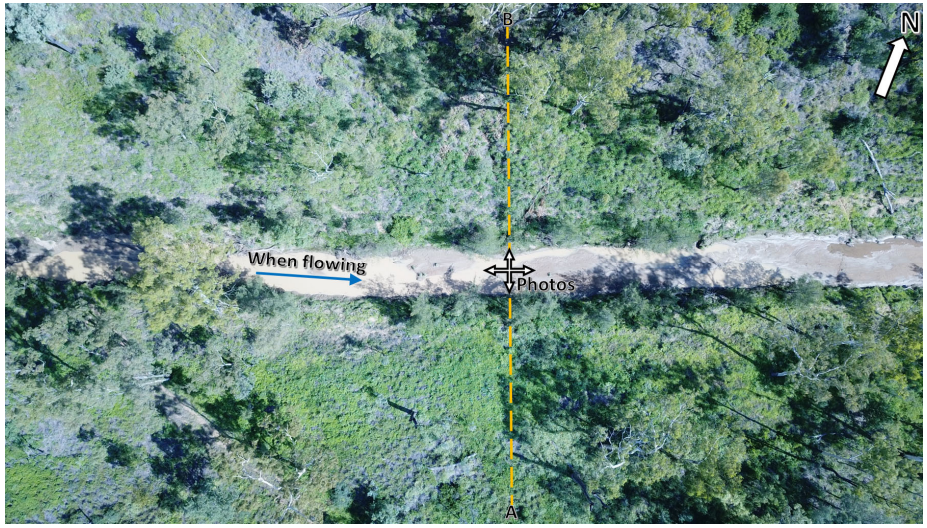
Physico-chemical water quality

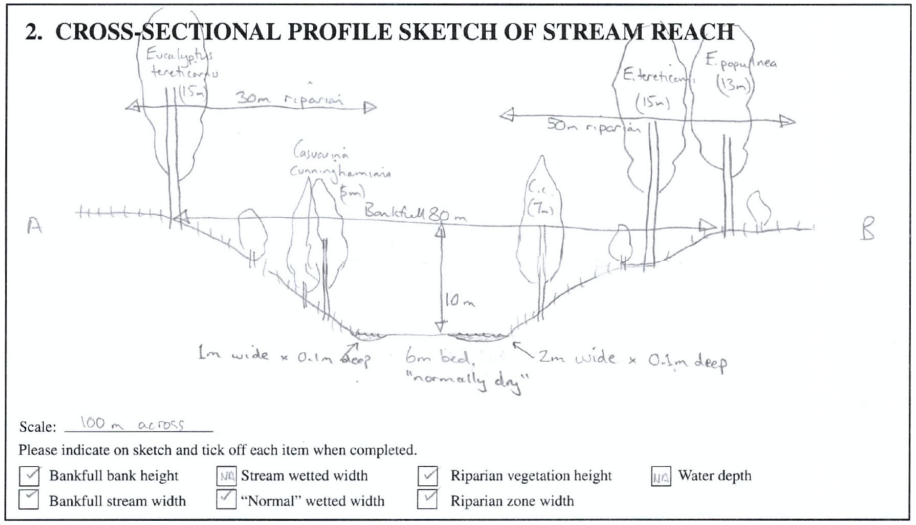
Collection time: 09:35; water temp.: 27.5˚C; specific conductivity: 264 µS/cm (fresh); turbidity: 842 NTU (poor clarity); dissolved oxygen: 47.4%, 3.7 mg/L (low, but typical for time of day); pH: 7.3 (neutral). Comments: Normal.

Bioassessment scores

Habitat assessment score for dry season: Poor (37).

Overall aquatic values – Dry season: **Moderate**.





Season: Dry

Site Code: R3 **Location:** Roper Creek **Stream order:** 4 **Latitude:** -22.8737 **Longitude:** 148.6417 **Date:** 14/10/2019


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; no local catchment erosion detected; infilled channel as a result of sand deposition; bank shape convex; banks moderately stable; bank vegetative stability excellent; bankfull width approx. 40 m and bankfull height approx. 5 m; lacking in-stream habitat features; bed substrates comprised approximately 95% sand (0.05-2 mm) and 5% silt / clay (<0.05 mm); upstream landuse includes coal mining and cattle grazing on partly cleared, partly remnant vegetation; adjacent land previously grazed, but not current.

Aquatic and riparian vegetation

Study reach positioned within riparian woodland State-mapped as RE 11.3.25 – '*Eucalyptus tereticornis* or *E. camaldulensis* woodland fringing drainage lines'; riparian zone approximately 25 m on the left bank and 25 m on the right, dominated by Queensland blue gum (*Eucalyptus tereticornis*) and river oak (*Casuarina cunninghamiana*), with abundant poplar box (*E. populnea*) and carbeen (*Corymbia tessellaris*); very sparse shrub layer, including castor oil plant (*Ricinus communis*)*, bean tree (*Cassia brewsteri*), and new growth Queensland blue gum and river oak; ground layer of upper bank dominated by buffel grass (*Cenchrus ciliaris*)*, with frequent green panic (*Megathyrsus maximus*)* and occasional cobbler's pegs (*Bidens pilosa*)*; ground layer of lower bank dominated by speargrass (*Heteropogon* sp.), with occasional spiny-head mat-rush (*Lomandra longifolia*) and Mexican poppy (*Argemone ochroleuca*)*; semi-aquatic macrophytes included little (1-10%) tall flatsedge (*Cyperus exaltatus*), rice sedge (*C. difformis*), common rush (*Juncus usitatus*) and white eclipta (*Eclipta prostrata*)*.

Erosion risk

Low – Banks appeared to be moderately stable, and with >80% of streambank surfaces covered by vegetation or tree roots.

Aquatic fauna, including breeding habitat

No aquatic fauna detected. May provide suitable foraging habitat for fish in times of flow. No fish, turtle or platypus breeding habitat detected.

Endangered, Vulnerable, Near Threatened (EVNT) or Special Least Concern (SLC) flora and fauna

No EVNT or SLC aquatic flora or fauna species detected. The Critically Endangered (EPBC Act; Endangered under 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 2019). The study reach is unlikely to provide suitable habitat for these species.

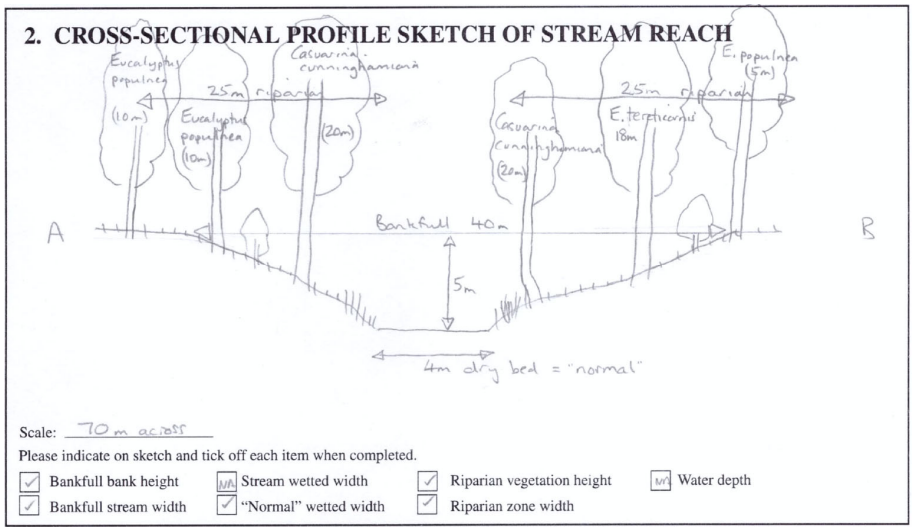
Physico-chemical water quality

Dry at the time of assessment.

Bioassessment scores

Habitat assessment score for dry season: Poor (38).

Overall aquatic values – Dry season: **Moderate**.



Season: Dry

Site Code: R3 **Location:** Roper Creek **Stream order:** 4 **Latitude:** -22.8737 **Longitude:** 148.6417 **Date:** 18/02/2020


Upstream


Left Bank


Downstream


Right Bank

General Site Description

Site attributes

Ephemeral fourth order drainage line; shallow pool habitat along the 100 m reach at the time of assessment; no discernible flow; well defined bed and banks; no local catchment erosion detected; infilled channel as a result of sand deposition; bank shape convex; banks moderately stable; bank vegetative stability excellent; bankfull width approx. 40 m and bankfull height approx. 5 m; lacking in-stream habitat features; bed substrates comprised approximately 95% sand (0.05-2 mm) and 5% silt / clay (<0.05 mm); upstream landuse includes coal mining and cattle grazing on partly cleared, partly remnant vegetation; adjacent land previously grazed, but not current.

Aquatic and riparian vegetation

Study reach positioned within riparian woodland State-mapped as RE 11.3.25 – '*Eucalyptus tereticornis* or *E. camaldulensis* woodland fringing drainage lines'; riparian zone approximately 25 m on the left bank and 25 m on the right, dominated by Queensland blue gum (*Eucalyptus tereticornis*) and river oak (*Casuarina cunninghamiana*), with abundant poplar box (*E. populnea*) and carbeen (*Corymbia tessellaris*); sparse shrub layer, including castor oil plant (*Ricinus communis*)*, bean tree (*Cassia brewsteri*), whitewood (*Atalaya hemiglauca*) and new growth Queensland blue gum and river oak; ground layer of upper bank dominated by buffel grass (*Cenchrus ciliaris*)* and green panic (*Megathyrsus maximus*)*, with frequent cobbler's pegs (*Bidens pilosa*)*; ground layer of lower bank dominated by green panic*, with frequent *Cyperus victoriensis*, occasional speargrass (*Heteropogon* sp.), spiny-head mat-rush (*Lomandra longifolia*), musk basil (*Basilicum polystachyon*), sneezeweed (*Centipeda minima*) and lesser joyweed (*Alternanthera denticulata*); semi-aquatic macrophytes included some (10-50%) *Cyperus victoriensis*, little (1-10%) tall flatsedge (*C. exaltatus*), rice sedge (*C. difformis*), white eclipta (*Eclipta prostrata*)*, common rush (*Juncus usitatus*) and willow primrose (*Ludwigia octovalvis*).

Erosion risk

Low – Banks appeared to be moderately stable, and with >80% of streambank surfaces covered by vegetation or tree roots.

Aquatic fauna, including breeding habitat

The reach provides foraging habitat for fish. Unlikely foraging habitat for turtles or platypus. Unlikely breeding habitat for fish, turtles or platypus. Aquatic vertebrate fauna detected by backpack electrofishing and overnight deployment of two baited fyke nets and five baited box traps included juvenile spangled perch (*Leiopotherpon unicolor*), eastern rainbowfish (*Melanotaenia splendida*) and Hyrtl's tandan (*Neosilurus hyrtlii*).

Endangered, Vulnerable, Near Threatened (EVNT) or Special Least Concern (SLC) flora and fauna

No EVNT or SLC aquatic flora or fauna species detected. The Critically Endangered (EPBC Act; Endangered under 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 2019). The study reach is unlikely to provide suitable habitat for these species.

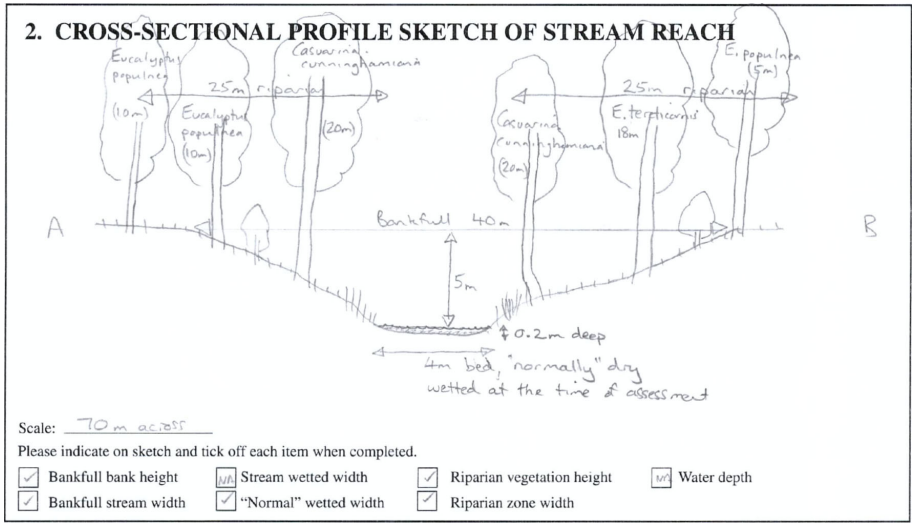
Physico-chemical water quality

Collection time: 15:15; water temp.: 30.7˚C; specific conductivity: 204 µS/cm (fresh); turbidity: 842 NTU (poor clarity); dissolved oxygen: 41.0%, 3.1 mg/L (low for time of day, but reflective of shading, poor light penetration and likely oxygen consumption associated with the breakdown of organic matter); pH: 7.1 (neutral). Comments: Normal.

Bioassessment scores

Habitat assessment score for dry season: Fair (44).

Overall aquatic values – Dry season: **Moderate**.



Season: Dry

Site Code: R4 **Location:** Roper Creek **Stream order:** 4 **Latitude:** -22.8681 **Longitude:** 148.6420 **Date:** 14/10/2019


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 (1-10%) stream bank erosion, mostly healed over; infilled channel as a result of sand deposition, with silt veneer; bank shape convex; banks moderately stable; bank vegetative stability excellent; bankfull width approx. 40 m and bankfull height approx. 6 m; lacking in-stream habitat features; bed substrates comprised approximately 30% sand (0.05-2 mm) and 70% silt/clay (<0.05 mm); upstream landuse includes coal mining and cattle grazing in partly cleared, partly remnant vegetation; adjacent land previously grazed, but not current.

Aquatic and riparian vegetation

Study reach positioned within riparian woodland State-mapped as RE 11.3.25 – '*Eucalyptus tereticornis* or *E. camaldulensis* woodland fringing drainage lines'; riparian zone approximately 20 m on the left bank and 20 m on the right, dominated by Queensland blue gum (*Eucalyptus tereticornis*), with abundant carbeen (*Corymbia tessellaris*) and river oak (*Casuarina cunninghamiana*), and frequent poplar box (*E. populnea*); very sparse shrub layer, including whitewood (*Atalaya hemiglauca*), bean tree (*Cassia brewsteri*) and new growth river oak; ground layer of the upper bank dominated by buffel grass (*Cenchrus ciliaris*)*, with frequent cobbler's pegs (*Bidens pilosa*)*; ground layer of the lower bank dominated by speargrass (*Heteropogon* sp.) and common couch (*Cynodon dactylon*), with occasional windmill grass (*Chloris* sp.), blady grass (*Imperata cylindrica*) and spiny-head mat-rush (*Lomandra longifolia*); semi-aquatic macrophytes included little (1-10%) tall flatsedge (*Cyperus exaltatus*), common rush (*Juncus usitatus*) and white eclipta (*Eclipta prostrata*)*.

Erosion risk

Low – Banks appeared to be moderately stable, and with >80% of streambank surfaces covered by vegetation or tree roots.

Aquatic fauna, including breeding habitat

No aquatic fauna detected. May provide suitable foraging habitat for fish in times of flow. No fish, turtle or platypus breeding habitat detected.

Endangered, Vulnerable, Near Threatened (EVNT) or Special Least Concern (SLC) flora and fauna

No EVNT or SLC aquatic flora or fauna species detected. The Critically Endangered (EPBC Act; Endangered under 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 2019). The study reach is unlikely to provide suitable habitat for these species.

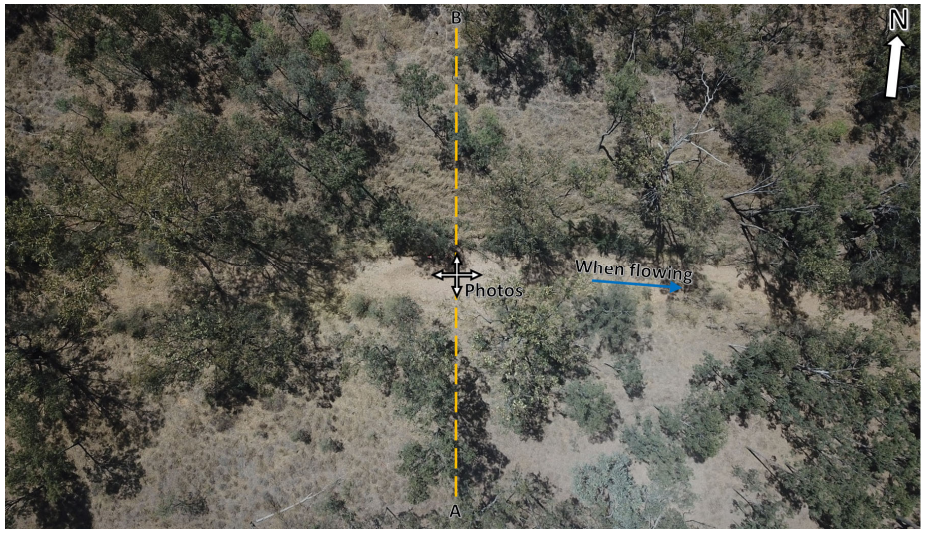
Physico-chemical water quality

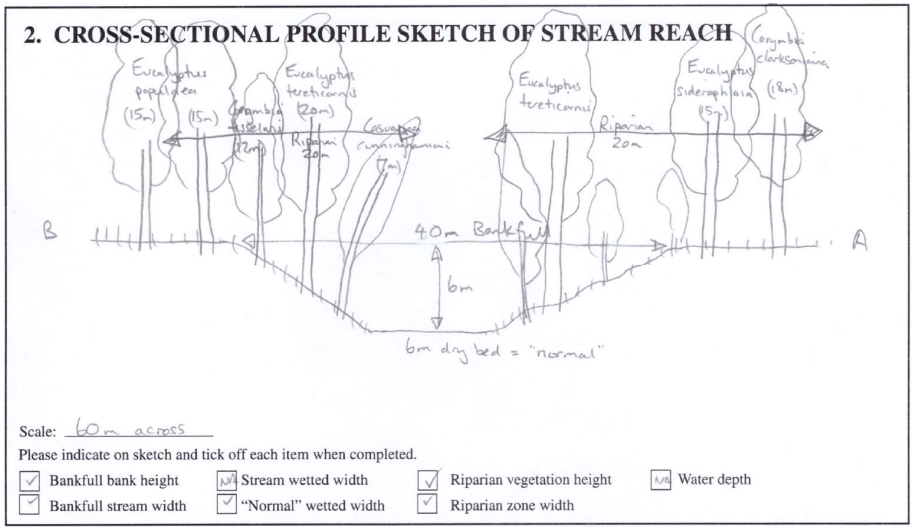
Dry at the time of assessment.

Bioassessment scores

Habitat assessment score for dry season: Poor (36).

Overall aquatic values – Dry season: **Moderate**.





Season: Dry

Site Code: R4 **Location:** Roper Creek **Stream order:** 4 **Latitude:** -22.8681 **Longitude:** 148.6420 **Date:** 18/02/2020

Upstream

Left Bank

Downstream

Right Bank

General Site Description

Site attributes

Ephemeral fourth order drainage line; isolated shallow pools at the time of assessment; well defined bed and banks; little (1-10%) stream bank erosion, mostly healed over; infilled channel as a result of sand deposition; highly mobile stream bed; bank shape convex; banks moderately stable; bank vegetative stability excellent; bankfull width approx. 40 m and bankfull height approx. 6 m; lacking in-stream habitat features; bed substrates comprised approximately 2% gravel (2-4 mm), 70% sand (0.05-2 mm) and 28% silt/clay (<0.05 mm); upstream landuse includes coal mining and cattle grazing in partly cleared, partly remnant vegetation; adjacent land previously grazed, but not current.

Aquatic and riparian vegetation

Study reach positioned within riparian woodland State-mapped as RE 11.3.25 – '*Eucalyptus tereticornis* or *E. camaldulensis* woodland fringing drainage lines'; riparian zone approximately 20 m on the left bank and 20 m on the right, dominated by Queensland blue gum (*Eucalyptus tereticornis*), abundant carbeen (*Corymbia tessellaris*), river oak (*Casuarina cunninghamiana*), and frequent poplar box (*E. populnea*); sparse shrub layer, including whitewood (*Atalaya hemiglauca*), bean tree (*Cassia brewsteri*), castor oil plant (*Ricinus communis*)* and new growth river oak; ground layer of the upper bank dominated by buffel grass (*Cenchrus ciliaris*)*, with frequent cobbler's pegs (*Bidens pilosa*)*; ground layer of the lower bank dominated by green panic (*Megathyrsus maximus*)* and common couch (*Cynodon dactylon*), with occasional speargrass (*Heteropogon* sp.), windmill grass (*Chloris* sp.), blady grass (*Imperata cylindrica*) and spiny-head mat-rush (*Lomandra longifolia*); semi-aquatic macrophytes included little (1-10%) *Cyperus victoriensis*, tall flatsedge (*C. exaltatus*), common rush (*Juncus usitatus*) and white eclipta (*Eclipta prostrata*)*.

Erosion risk

Low – Banks appeared to be moderately stable, and with >95% of streambank surfaces covered by vegetation or tree roots.

Aquatic fauna, including breeding habitat

The reach provides foraging habitat for fish. Unlikely foraging habitat for turtles or platypus. Unlikely breeding habitat for fish, turtles or platypus. Aquatic vertebrate fauna detected by backpack electrofishing comprised juvenile spangled perch (*Leiopotherpon unicolor*).

Endangered, Vulnerable, Near Threatened (EVNT) or Special Least Concern (SLC) flora and fauna

No EVNT or SLC aquatic flora or fauna species detected. The Critically Endangered (EPBC Act; Endangered under 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 2019). The study reach is unlikely to provide suitable habitat for these species.

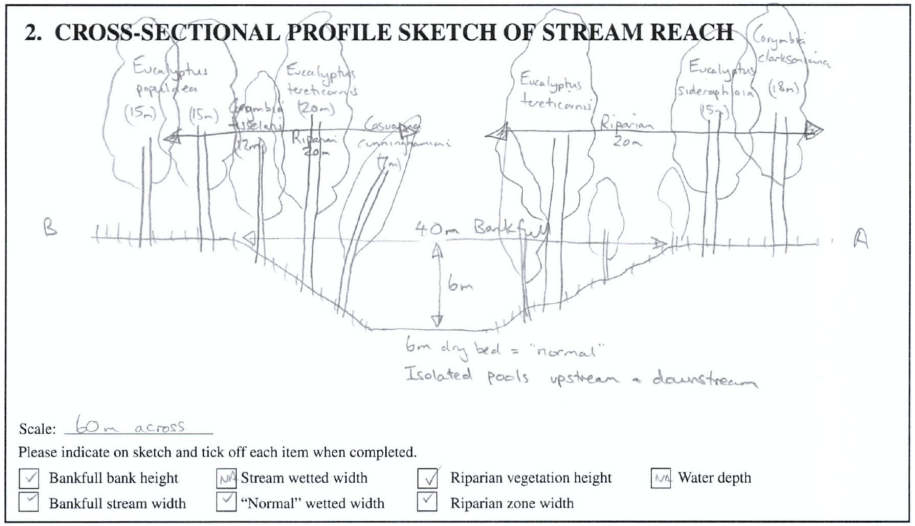
Physico-chemical water quality

Collection time: 11:50; water temp.: 29.2˚C; specific conductivity: 258 µS/cm (fresh); turbidity: 398 NTU (poor clarity); dissolved oxygen: 68.4%, 4.8 mg/L (low for time of day, but reflective of shading, poor light penetration and likely oxygen consumption associated with the breakdown of organic matter); pH: 7.4 (mildly alkaline). Comments: Normal.

Bioassessment scores

Habitat assessment score for dry season: Fair (39).

Overall aquatic values – Dry season: **Moderate**.



Season: Dry

Site Code: R5 **Location:** Thirteen Miles Gully **Stream order:** 2 **Latitude:** -22.8681 **Longitude:** 148.6705 **Date:** 14/10/2019


Upstream


Left Bank


Downstream


Right Bank

General Site Description

Site attributes

Ephemeral second order drainage line; dry at the time of assessment; well defined bed and banks; little (1-10%) stream bank erosion; U shaped channel; bank shape concave; banks moderately stable; 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 snags and large woody debris; bed substrates comprised approximately 20% sand (0.05-2 mm), 80% silt (<0.05 mm); upstream landuse includes coal mining and cattle grazing in partly cleared, partly remnant vegetation; adjacent land previously grazed, but not current.

Aquatic and riparian vegetation

Study reach positioned within riparian woodland State-mapped as non-remnant; riparian zone approximately 10 m on the left bank and 10 m on the right, dominated by Queensland blue gum (*Eucalyptus tereticornis*), with frequent river oak (*Casuarina cunninghamiana*), yellowwood (*Terminalia oblongata*), and occasional brigalow (*Acacia harpophylla*); sparse shrub layer, including bean tree (*Cassia brewsteri*), baunhinia (*Lysiphyllum* sp.), mimosa bush (*Vachellia farnesiana*)* and new growth Queensland blue gum; ground layer of the upper bank dominated by buffel grass (*Cenchrus ciliaris*)*; ground layer of the lower bank dominated by sneezeweed (*Centipeda minima*), with occasional green panic (*Megathyrsus maximus*)*, speargrass (*Heteropogon* sp.), fleabane (*Conyza bonariensis*)* and windmill grass (*Chloris* sp.); semi-aquatic macrophytes included little (1-10%) common rush (*Juncus usitatus*) and tall flatsedge (*Cyperus exaltatus*).

Erosion risk

Low – Banks appeared to be moderately stable, and with 50-79% of streambank surfaces covered by vegetation or tree roots.

Aquatic fauna, including breeding habitat

No aquatic fauna detected. May provide suitable foraging habitat for fish in times of flow. No fish, turtle or platypus breeding habitat detected.

Endangered, Vulnerable, Near Threatened (EVNT) or Special Least Concern (SLC) flora and fauna

No EVNT or SLC aquatic flora or fauna species detected. The Critically Endangered (EPBC Act; Endangered under 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 2019). The study reach is unlikely to provide suitable habitat for these species.

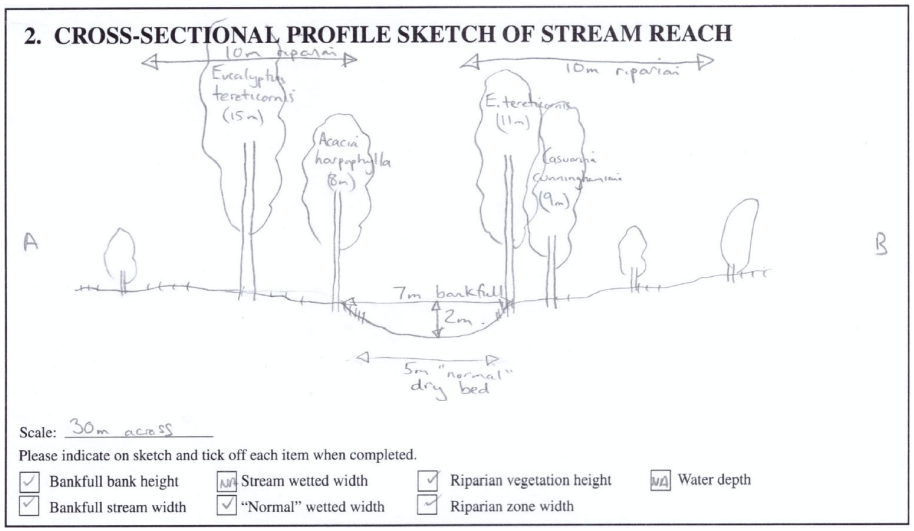
Physico-chemical water quality

Dry at the time of assessment.

Bioassessment scores

Habitat assessment score for dry season: Fair (56).

Overall aquatic values – Dry season: **Low**.



Season: Dry

Site Code: R5 **Location:** Thirteen Miles Gully **Stream order:** 2 **Latitude:** -22.8681 **Longitude:** 148.6705 **Date:** 19/02/2020


Upstream


Left Bank


Downstream


Right Bank

General Site Description

Site attributes

Ephemeral second order drainage line; dry at the time of assessment; well defined bed and banks; little (1-10%) stream bank erosion; U shaped channel; bank shape concave; banks moderately stable; 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 snags and large woody debris; bed substrates comprised approximately 20% sand (0.05-2 mm), 80% silt (<0.05 mm); upstream landuse includes coal mining and cattle grazing in partly cleared, partly remnant vegetation; adjacent land previously grazed, but not current.

Aquatic and riparian vegetation

Study reach positioned within riparian woodland State-mapped as non-remnant; riparian zone approximately 10 m on the left bank and 10 m on the right, dominated by Queensland blue gum (*Eucalyptus tereticornis*), with frequent river oak (*Casuarina cunninghamiana*), yellowwood (*Terminalia oblongata*), and occasional brigalow (*Acacia harpophylla*); sparse shrub layer, including bean tree (*Cassia brewsteri*), baunhinia (*Lysiphyllum* sp.), mimosa bush (*Vachellia farnesiana*)* and new growth Queensland blue gum; ground layer of the upper bank dominated by buffel grass (*Cenchrus ciliaris*)*; ground layer of the lower bank dominated by sneezeweed (*Centipeda minima*), with frequent hairy carpet weed (*Glinus lotoides*), occasional green panic (*Megathyrsus maximus*)*, black speargrass (*Heteropogon contortus*), fleabane (*Conyza bonariensis*)*, windmill grass (*Chloris* sp.), lesser joyweed (*Alternanthera denticulata*), perennial cupgrass (*Eriochloa pseudoacrotricha*) and button grass (*Dactyloctenium radulans*); semi-aquatic macrophytes included little (1-10%) *Cyperus betchei*, *Cyperus iria*, tall flatsedge (*Cyperus exaltatus*), awnless barnyard grass (*Echonochloa colona*)*, common rush (*Juncus usitatus*) and umbrella canegrass (*Leptochloa digitata*).

Erosion risk

Low – Banks appeared to be moderately stable, and with 50-79% of streambank surfaces covered by vegetation or tree roots.

Aquatic fauna, including breeding habitat

No aquatic fauna detected. May provide suitable foraging habitat for fish in times of flow. No fish, turtle or platypus breeding habitat detected.

Endangered, Vulnerable, Near Threatened (EVNT) or Special Least Concern (SLC) flora and fauna

No EVNT or SLC aquatic flora or fauna species detected. The Critically Endangered (EPBC Act; Endangered under 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 2019). The study reach is unlikely to provide suitable habitat for these species.

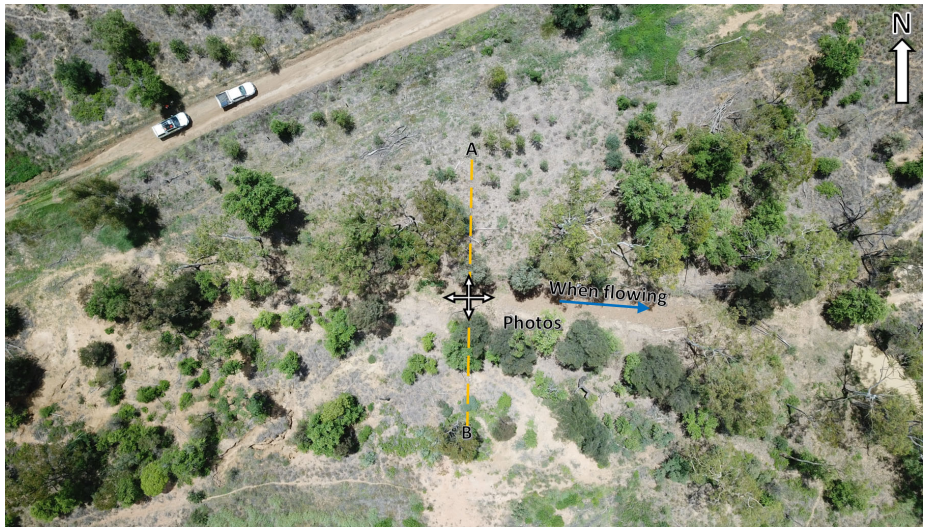
Physico-chemical water quality

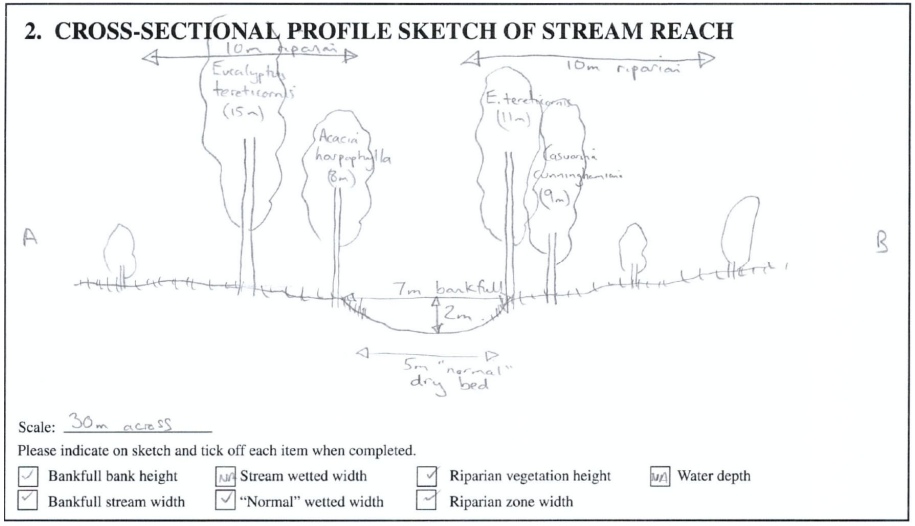
Dry at the time of assessment.

Bioassessment scores

Habitat assessment score for dry season: Fair (56).

Overall aquatic values – Dry season: **Low**.





Appendix C: Water Sampling Analytical Results

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EB2005513**	Page	: 1 of 5
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	: DPM19015 Middlemount Coal Mine Southern Extension Project	Date Samples Received	: 27-Feb-2020 12:09
Order number	: ----	Date Analysis Commenced	: 02-Mar-2020
C-O-C number	: ----	Issue Date	: 05-Mar-2020 15:38
Sampler	: DAVID MOORE		
Site	: ----		
Quote number	: BN/558/14		
No. of samples received	: 15		
No. of samples analysed	: 15		

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*
Mark Hallas	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.

- Ionic Balance out of acceptable limits for samples due to analytes not quantified in this report.
- 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	R1	R2	R3	R4	FB
				Client sampling date / time	18-Feb-2020 00:00	19-Feb-2020 00:00	18-Feb-2020 00:00	18-Feb-2020 00:00	18-Feb-2020 00:00
Compound	CAS Number	LOR	Unit		EB2005513-001	EB2005513-002	EB2005513-003	EB2005513-004	EB2005513-005
					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		**83**	**61**	**55**	**77**	**5**
Total Alkalinity as CaCO3	----	1	mg/L		**83**	**61**	**55**	**77**	**5**
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L		**10**	**14**	**12**	**15**	<1
ED045G: Chloride by Discrete Analyser									
Chloride	16887-00-6	1	mg/L		**24**	**29**	**26**	**31**	<1
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L		**15**	**12**	**10**	**14**	<1
Magnesium	7439-95-4	1	mg/L		**9**	**7**	**6**	**8**	<1
Sodium	7440-23-5	1	mg/L		**28**	**30**	**27**	**33**	<1
Potassium	7440-09-7	1	mg/L		**7**	**6**	**5**	**6**	<1
ED093F: SAR and Hardness Calculations									
Total Hardness as CaCO3	----	1	mg/L		**74**	**59**	**50**	**68**	<1
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L		**0.2**	**0.2**	**0.2**	**0.2**	<0.1
EN055: Ionic Balance									
ø Total Anions	----	0.01	meq/L		**2.54**	**2.33**	**2.08**	**2.72**	**0.10**
ø Total Cations	----	0.01	meq/L		**2.89**	**2.63**	**2.30**	**2.94**	<0.01

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	DUP	MW3	MW5	MW6	MW9A
				Client sampling date / time	18-Feb-2020 00:00	19-Feb-2020 00:00	21-Feb-2020 00:00	20-Feb-2020 00:00	20-Feb-2020 00:00
Compound	CAS Number	LOR	Unit		EB2005513-006	EB2005513-008	EB2005513-009	EB2005513-010	EB2005513-011
					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		82	526	459	408	456
Total Alkalinity as CaCO3	----	1	mg/L		82	526	459	408	456
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L		10	868	582	411	114
ED045G: Chloride by Discrete Analyser									
Chloride	16887-00-6	1	mg/L		24	7970	5500	11500	10200
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L		15	246	114	279	393
Magnesium	7439-95-4	1	mg/L		9	581	313	793	480
Sodium	7440-23-5	1	mg/L		28	4330	3220	7310	6000
Potassium	7440-09-7	1	mg/L		7	10	7	22	19
ED093F: SAR and Hardness Calculations									
Total Hardness as CaCO3	----	1	mg/L		74	3010	1570	3960	2960
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L		0.2	0.4	0.7	0.6	0.3
EN055: Ionic Balance									
ø Total Anions	----	0.01	meq/L		2.52	253	176	341	299
ø Total Cations	----	0.01	meq/L		2.89	249	172	398	320
ø Ionic Balance	----	0.01	%		----	0.94	1.36	7.66	3.45

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	MW15A	BH302	MW17A	MW14A	MW16A
				Client sampling date / time	20-Feb-2020 00:00	20-Feb-2020 00:00	20-Feb-2020 00:00	21-Feb-2020 00:00	21-Feb-2020 00:00
Compound	CAS Number	LOR	Unit		EB2005513-012	EB2005513-013	EB2005513-014	EB2005513-015	EB2005513-016
					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		720	481	409	384	889
Total Alkalinity as CaCO3	----	1	mg/L		720	481	409	384	889
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L		104	144	251	198	193
ED045G: Chloride by Discrete Analyser									
Chloride	16887-00-6	1	mg/L		1680	2530	6830	10900	1550
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L		82	80	547	659	112
Magnesium	7439-95-4	1	mg/L		109	97	664	887	128
Sodium	7440-23-5	1	mg/L		1200	1770	3580	6120	1150
Potassium	7440-09-7	1	mg/L		6	8	26	13	16
ED093F: SAR and Hardness Calculations									
Total Hardness as CaCO3	----	1	mg/L		654	599	4100	5300	807
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L		1.0	1.2	0.2	1.0	0.7
EN055: Ionic Balance									
ø Total Anions	----	0.01	meq/L		63.9	84.0	206	319	65.5
ø Total Cations	----	0.01	meq/L		65.4	89.2	238	372	66.6
ø Ionic Balance	----	0.01	%		1.14	3.00	7.26	7.68	0.80

ALS Environmental

QUALITY CONTROL REPORT

Work Order	: **EB2005513**	Page	: 1 of 5
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	: DPM19015 Middlemount Coal Mine Southern Extension Project	Date Samples Received	: 27-Feb-2020
Order number	: ----	Date Analysis Commenced	: 02-Mar-2020
C-O-C number	: ----	Issue Date	: 05-Mar-2020
Sampler	: DAVID MOORE		
Site	: ----		
Quote number	: BN/558/14		
No. of samples received	: 15		
No. of samples analysed	: 15		

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*
Mark Hallas	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: 2888061)									
EB2005513-003	R3	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	55	56	2.78	0% - 20%
		ED037-P: Total Alkalinity as CaCO3	----	1	mg/L	55	56	2.78	0% - 20%
EB2005504-006	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	<1	<1	0.00	No Limit
		ED037-P: Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	650	658	1.25	0% - 20%
		ED037-P: Total Alkalinity as CaCO3	----	1	mg/L	650	658	1.25	0% - 20%
ED037P: Alkalinity by PC Titrator (QC Lot: 2888062)									
EB2005537-001	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	47	42	10.6	0% - 20%
		ED037-P: Total Alkalinity as CaCO3	----	1	mg/L	47	42	10.6	0% - 20%
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA (QC Lot: 2889416)									
EB2005362-001	Anonymous	ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	19	19	0.00	0% - 50%
EB2005513-006	DUP	ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	10	10	0.00	0% - 50%
ED045G: Chloride by Discrete Analyser (QC Lot: 2889417)									
EB2005362-001	Anonymous	ED045G: Chloride	16887-00-6	1	mg/L	45	41	9.04	0% - 20%
EB2005513-006	DUP	ED045G: Chloride	16887-00-6	1	mg/L	24	24	0.00	0% - 20%
ED093F: Dissolved Major Cations (QC Lot: 2885155)									
EB2005316-008	Anonymous	ED093F: Calcium	7440-70-2	1	mg/L	35	36	2.90	0% - 20%
		ED093F: Magnesium	7439-95-4	1	mg/L	18	19	0.00	0% - 50%
		ED093F: Sodium	7440-23-5	1	mg/L	226	227	0.682	0% - 20%
		ED093F: Potassium	7440-09-7	1	mg/L	91	95	4.31	0% - 20%

Sub-Matrix: **WATER**

Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Laboratory Duplicate (DUP) Report					
				LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
ED093F: Dissolved Major Cations (QC Lot: 2885155) - continued									
EB2005504-007	Anonymous	ED093F: Calcium	7440-70-2	1	mg/L	22	21	0.00	0% - 20%
		ED093F: Magnesium	7439-95-4	1	mg/L	17	17	0.00	0% - 50%
		ED093F: Sodium	7440-23-5	1	mg/L	36	36	0.00	0% - 20%
		ED093F: Potassium	7440-09-7	1	mg/L	8	8	0.00	No Limit
ED093F: Dissolved Major Cations (QC Lot: 2885158)									
EB2005572-002	Anonymous	ED093F: Calcium	7440-70-2	1	mg/L	752	777	3.29	0% - 20%
		ED093F: Magnesium	7439-95-4	1	mg/L	2100	2150	2.68	0% - 20%
		ED093F: Sodium	7440-23-5	1	mg/L	12000	12300	2.98	0% - 20%
		ED093F: Potassium	7440-09-7	1	mg/L	205	210	2.35	0% - 20%
EK040P: Fluoride by PC Titrator (QC Lot: 2888060)									
EB2005513-003	R3	EK040P: Fluoride	16984-48-8	0.1	mg/L	0.2	0.2	0.00	No Limit
EB2005504-006	Anonymous	EK040P: Fluoride	16984-48-8	0.1	mg/L	<0.1	<0.1	0.00	No Limit
EK040P: Fluoride by PC Titrator (QC Lot: 2888063)									
EB2005537-001	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: 2888061)								
ED037-P: Total Alkalinity as CaCO3	----	----	mg/L	----	200 mg/L	96.5	80.0	120
ED037P: Alkalinity by PC Titrator (QCLot: 2888062)								
ED037-P: Total Alkalinity as CaCO3	----	----	mg/L	----	50 mg/L	108	80.0	120
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA (QCLot: 2889416)								
ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	<1	25 mg/L	107	85.0	118
				<1	100 mg/L	107	85.0	118
ED045G: Chloride by Discrete Analyser (QCLot: 2889417)								
ED045G: Chloride	16887-00-6	1	mg/L	<1	10 mg/L	93.7	90.0	115
				<1	1000 mg/L	102	90.0	115
ED093F: Dissolved Major Cations (QCLot: 2885155)								
ED093F: Calcium	7440-70-2	1	mg/L	<1	50 mg/L	112	70.0	130
ED093F: Magnesium	7439-95-4	1	mg/L	<1	50 mg/L	121	70.0	130
ED093F: Sodium	7440-23-5	1	mg/L	<1	50 mg/L	123	70.0	130
ED093F: Potassium	7440-09-7	1	mg/L	<1	50 mg/L	116	70.0	130
ED093F: Dissolved Major Cations (QCLot: 2885158)								
ED093F: Calcium	7440-70-2	1	mg/L	<1	50 mg/L	95.2	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	105	70.0	130
ED093F: Potassium	7440-09-7	1	mg/L	<1	50 mg/L	98.0	70.0	130
EK040P: Fluoride by PC Titrator (QCLot: 2888060)								
EK040P: Fluoride	16984-48-8	0.1	mg/L	<0.1	5 mg/L	92.8	80.0	117
EK040P: Fluoride by PC Titrator (QCLot: 2888063)								
EK040P: Fluoride	16984-48-8	0.1	mg/L	<0.1	10 mg/L	108	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: 2889416)							
EB2005362-002	Anonymous	ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	20 mg/L	82.8	70.0	130

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
ED045G: Chloride by Discrete Analyser (QCLot: 2889417)							
EB2005362-002	Anonymous	ED045G: Chloride	16887-00-6	400 mg/L	108	70.0	130
EK040P: Fluoride by PC Titrator (QCLot: 2888060)							
EB2005504-002	Anonymous	EK040P: Fluoride	16984-48-8	5 mg/L	96.8	70.0	130
EK040P: Fluoride by PC Titrator (QCLot: 2888063)							
EB2005513-015	MW14A	EK040P: Fluoride	16984-48-8	5 mg/L	91.2	70.0	130

QA/QC Compliance Assessment to assist with Quality Review

Work Order	: **EB2005513**	Page	: 1 of 6
Client	: **DPM ENVIROSCIENCES**	Laboratory	: Environmental Division Brisbane
Contact	: MR DAVID MOORE	Telephone	: +61-7-3243 7222
Project	: DPM19015 Middlemount Coal Mine Southern Extension Project	Date Samples Received	: 27-Feb-2020
Site	: ----	Issue Date	: 05-Mar-2020
Sampler	: DAVID MOORE	No. of samples received	: 15
Order number	: ----	No. of samples analysed	: 15

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) R1, R3, R4, FB, DUP	**18-Feb-2020**	**----**	----	----	**02-Mar-2020**	03-Mar-2020	✓
Clear Plastic Bottle - Natural (ED037-P) R2, MW3	**19-Feb-2020**	**----**	----	----	**02-Mar-2020**	04-Mar-2020	✓
Clear Plastic Bottle - Natural (ED037-P) MW6, MW9A, MW15A, BH302, MW17A	**20-Feb-2020**	**----**	----	----	**02-Mar-2020**	05-Mar-2020	✓
Clear Plastic Bottle - Natural (ED037-P) MW5, MW14A, MW16A	**21-Feb-2020**	**----**	----	----	**02-Mar-2020**	06-Mar-2020	✓
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA							
Clear Plastic Bottle - Natural (ED041G) R1, R3, R4, FB, DUP	**18-Feb-2020**	**----**	----	----	**03-Mar-2020**	17-Mar-2020	✓
Clear Plastic Bottle - Natural (ED041G) R2, MW3	**19-Feb-2020**	**----**	----	----	**03-Mar-2020**	18-Mar-2020	✓
Clear Plastic Bottle - Natural (ED041G) MW6, MW9A, MW15A, BH302, MW17A	**20-Feb-2020**	**----**	----	----	**03-Mar-2020**	19-Mar-2020	✓
Clear Plastic Bottle - Natural (ED041G) MW5, MW14A, MW16A	**21-Feb-2020**	**----**	----	----	**03-Mar-2020**	20-Mar-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
ED045G: Chloride by Discrete Analyser							
Clear Plastic Bottle - Natural (ED045G) R1, R3, R4, FB, DUP	**18-Feb-2020**	**----**	----	----	**03-Mar-2020**	17-Mar-2020	✓
Clear Plastic Bottle - Natural (ED045G) R2, MW3	**19-Feb-2020**	**----**	----	----	**03-Mar-2020**	18-Mar-2020	✓
Clear Plastic Bottle - Natural (ED045G) MW6, MW9A, MW15A, BH302, MW17A	**20-Feb-2020**	**----**	----	----	**03-Mar-2020**	19-Mar-2020	✓
Clear Plastic Bottle - Natural (ED045G) MW5, MW14A, MW16A	**21-Feb-2020**	**----**	----	----	**03-Mar-2020**	20-Mar-2020	✓
ED093F: Dissolved Major Cations							
Clear Plastic Bottle - Nitric Acid; Filtered (ED093F) R1, R3, R4, FB, DUP	**18-Feb-2020**	**----**	----	----	**02-Mar-2020**	17-Mar-2020	✓
Clear Plastic Bottle - Nitric Acid; Filtered (ED093F) R2, MW3	**19-Feb-2020**	**----**	----	----	**02-Mar-2020**	18-Mar-2020	✓
Clear Plastic Bottle - Nitric Acid; Filtered (ED093F) MW6, MW9A, MW15A, BH302, MW17A	**20-Feb-2020**	**----**	----	----	**02-Mar-2020**	19-Mar-2020	✓
Clear Plastic Bottle - Nitric Acid; Filtered (ED093F) MW5, MW14A, MW16A	**21-Feb-2020**	**----**	----	----	**02-Mar-2020**	20-Mar-2020	✓
ED093F: SAR and Hardness Calculations							
Clear Plastic Bottle - Nitric Acid; Filtered (ED093F) R1, R3, R4, FB, DUP	**18-Feb-2020**	**----**	----	----	**02-Mar-2020**	17-Mar-2020	✓
Clear Plastic Bottle - Nitric Acid; Filtered (ED093F) R2, MW3	**19-Feb-2020**	**----**	----	----	**02-Mar-2020**	18-Mar-2020	✓
Clear Plastic Bottle - Nitric Acid; Filtered (ED093F) MW6, MW9A, MW15A, BH302, MW17A	**20-Feb-2020**	**----**	----	----	**02-Mar-2020**	19-Mar-2020	✓
Clear Plastic Bottle - Nitric Acid; Filtered (ED093F) MW5, MW14A, MW16A	**21-Feb-2020**	**----**	----	----	**02-Mar-2020**	20-Mar-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
EK040P: Fluoride by PC Titrator							
Clear Plastic Bottle - Natural (EK040P) R1, R3, R4, FB, DUP	**18-Feb-2020**	**----**	----	----	**02-Mar-2020**	17-Mar-2020	✓
Clear Plastic Bottle - Natural (EK040P) R2, MW3	**19-Feb-2020**	**----**	----	----	**02-Mar-2020**	18-Mar-2020	✓
Clear Plastic Bottle - Natural (EK040P) MW6, MW9A, MW15A, BH302, MW17A	**20-Feb-2020**	**----**	----	----	**02-Mar-2020**	19-Mar-2020	✓
Clear Plastic Bottle - Natural (EK040P) MW5, MW14A, MW16A	**21-Feb-2020**	**----**	----	----	**02-Mar-2020**	20-Mar-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	30	**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	3	24	**12.50**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Major Cations - Dissolved	ED093F	3	29	**10.34**	**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	2	30	**6.67**	**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	2	24	**8.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Major Cations - Dissolved	ED093F	2	29	**6.90**	**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	2	24	**8.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Major Cations - Dissolved	ED093F	2	29	**6.90**	**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	2	24	**8.33**	**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

SAMPLE RECEIPT NOTIFICATION (SRN)

Work Order : **EB2005513**

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
E-mail	: dmoore@dpm-enviro.com.au	E-mail	: ALSEnviro.Brisbane@alsglobal.com
Telephone	: ----	Telephone	: +61-7-3243 7222
Facsimile	: ----	Facsimile	: +61-7-3243 7218
Project	: DPM19015 Middlemount Coal Mine Southern Extension Project	Page	: 1 of 2
Order number	: ----	Quote number	: EB2014DPMENV0001 (BN/558/14)
C-O-C number	: ----	QC Level	: NEPM 2013 B3 & ALS QC Standard
Site	: ----		
Sampler	: DAVID MOORE		

Dates

Date Samples Received	: 27-Feb-2020 12:09	Issue Date	: 27-Feb-2020
Client Requested Due Date	: 05-Mar-2020	Scheduled Reporting Date	: **05-Mar-2020**

Delivery Details

Mode of Delivery	: Client Drop Off	Security Seal	: Not Available
No. of coolers/boxes	: 1	Temperature	: 18.3°C
Receipt Detail	: MED ESKY	No. of samples received / analysed	: 15 / 15

General Comments

- This report contains the following information:
  - Sample Container(s)/Preservation Non-Compliances
  - Summary of Sample(s) and Requested Analysis
  - Proactive Holding Time Report
  - Requested Deliverables
- Discounted Package Prices apply only when specific ALS Group Codes ('W', 'S', 'NT' suites) are referenced on COCs.
- **Please be advised that sample "MW2" was not received at the laboratory (denoted SNR on the scanned COC).**
- Please direct any turn around / technical queries to the laboratory contact designated above.
- Sample Disposal - Aqueous (3 weeks), Solid (2 months ± 1 week) from receipt of samples.
- Analysis will be conducted by ALS Environmental, Brisbane, NATA accreditation no. 825, Site No. 818 (Micro site no. 18958).
- **Breaches in recommended extraction / analysis holding times (if any) are displayed overleaf in the Proactive Holding Time Report table.**
- Please be aware that APHA/NEPM recommends water and soil samples be chilled to less than or equal to 6°C for chemical analysis, and less than or equal to 10°C but unfrozen for Microbiological analysis. Where samples are received above this temperature, it should be taken into consideration when interpreting results. Refer to ALS EnviroMail 85 for ALS recommendations of the best practice for chilling samples after sampling and for maintaining a cool temperature during transit.

Sample Container(s)/Preservation Non-Compliances

All comparisons are made against pretreatment/preservation AS, APHA, USEPA standards.

- **No sample container / preservation non-compliance exists.**

Summary of Sample(s) and Requested Analysis

Some items described below may be part of a laboratory process necessary for the execution of client requested tasks. Packages may contain additional analyses, such as the determination of moisture content and preparation tasks, that are included in the package.
If no sampling time is provided, the sampling time will default 00:00 on the date of sampling. If no sampling date is provided, the sampling date will be assumed by the laboratory and displayed in brackets without a time component

Matrix: **WATER**

Laboratory sample ID	Client sampling date / time	Client sample ID	WATER - NT-01D & 02A Major Cations & Anions (Ca, Mg, Na, K, Cl, SO4,
EB2005513-001	18-Feb-2020 00:00	R1	✓
EB2005513-002	19-Feb-2020 00:00	R2	✓
EB2005513-003	18-Feb-2020 00:00	R3	✓
EB2005513-004	18-Feb-2020 00:00	R4	✓
EB2005513-005	18-Feb-2020 00:00	FB	✓
EB2005513-006	18-Feb-2020 00:00	DUP	✓
EB2005513-008	19-Feb-2020 00:00	MW3	✓
EB2005513-009	21-Feb-2020 00:00	MW5	✓
EB2005513-010	20-Feb-2020 00:00	MW6	✓
EB2005513-011	20-Feb-2020 00:00	MW9A	✓
EB2005513-012	20-Feb-2020 00:00	MW15A	✓
EB2005513-013	20-Feb-2020 00:00	BH302	✓
EB2005513-014	20-Feb-2020 00:00	MW17A	✓
EB2005513-015	21-Feb-2020 00:00	MW14A	✓
EB2005513-016	21-Feb-2020 00:00	MW16A	✓

Proactive Holding Time Report

Sample(s) have been received within the recommended holding times for the requested analysis.

Requested Deliverables

DAVID MOORE

- *AU Certificate of Analysis - NATA (COA)	Email	dmoore@dpm-enviro.com.au
- *AU Interpretive QC Report - DEFAULT (Anon QCI Rep) (QCI)	Email	dmoore@dpm-enviro.com.au
- *AU QC Report - DEFAULT (Anon QC Rep) - NATA (QC)	Email	dmoore@dpm-enviro.com.au
- A4 - AU Sample Receipt Notification - Environmental HT (SRN)	Email	dmoore@dpm-enviro.com.au
- A4 - AU Tax Invoice (INV)	Email	dmoore@dpm-enviro.com.au
- Chain of Custody (CoC) (COC)	Email	dmoore@dpm-enviro.com.au
- EDI Format - ENMRG (ENMRG)	Email	dmoore@dpm-enviro.com.au
- EDI Format - XTab (XTAB)	Email	dmoore@dpm-enviro.com.au

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

☐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.c

☐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

'ollongong NSW 2500

5/3.

Environmental Divisio'
Brisbane

Work Order Reference
EB2005513

Telephone : + 61-7-3243 7222

CLIENT: DPM Envirosciences Pty Ltd	**TURNAROUND REQUIREMENTS :** (Standard TAT may be longer for some tests e.g.. Ultra Trace Organics)	☒ Standard TAT **(List due date):**	No N/A
OFFICE: 12 Lauren Drive, Buderim QLD 4556		☐ Non Standard or urgent TAT **(List due date):**	No N/A
PROJECT: Middlemount Coal Mine Southern Extension Projec **PROJECT NO** DPM19015	**ALS QUOTE NO.:** BN/558/14	**COC SEQUENCE NUMBER (Circle)** COC: 1 2 3 4 5 6	°C
ORDER NUMBER: **PURCHASE ORDER NO.:**	**COUNTRY OF ORIGIN:** Australia	OF: 1 2 3 4 5 6	
PROJECT MANAGER: David Moore	**CONTACT PH:** 0427 694 433		
SAMPLER: David Moore	**SAMPLER MOBILE:** 0427 694 433	**RELINQUISHED BY:** P. MOORE	**RECEIVED BY:** S Butler
COC Emailed to ALS? (YES / NO)	**EDD FORMAT (or default):**	DATE/TIME: 27/2/20 12-09	DATE/TIME: 27/2/2020 12:04
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			

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	R1	18/02/2020	W	P, N	2	✓	✓							
2	R2	19/02/2020	W	P, N	2	✓	✓							
3	R3	18/02/2020	W	P, N	2	✓	✓							
4	R4	18/02/2020	W	P, N	2	✓	✓							
5	FB	18/02/2020	W	P, N	2	✓	✓							
6	DUP	18/02/2020	W	P, N	2	✓	✓							
SNR 7	MW2	21/02/2020	W	P, N	2	✓	✓							
8	MW3	19/02/2020	W	P, N	2	✓	✓							
9	MW5	21/02/2020	W	P, N	2	✓	✓							
10	MW6	20/02/2020	W	P, N	2	✓	✓							
11	MW9A	20/02/2020	W	P, N	2	✓	✓							
12	MW15A	20/02/2020	W	P, N	2	✓	✓							
				TOTAL										

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.

CUSTODY

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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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

DPM Envirosciences Pty Ltd	**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):**
OFFICE: 12 Lauren Drive, Buderim QLD 4556		
PROJECT: Middlemount Coal Mine Southern Extension Projec **PROJECT NO** DPM19015	**ALS QUOTE NO.:** BN/558/14	**COC SEQUENCE NUMBER (Circle)** COC: 1 2 3 4 5 6 7 OF: 1 2 3 4 5 6 7
ORDER NUMBER: **PURCHASE ORDER NO.:**	**COUNTRY OF ORIGIN:** Australia	
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		

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:
P.MOORE	JB		
DATE/TIME: 27/2/20 12:09.	DATE/TIME: 29/2/2020 12:04	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.
13	BH302	20/02/2020	W	P, N	2	✓	✓							
14	MW17A	20/02/2020	W	P, N	2	✓	✓							
15	MW14A	21/02/2020	W	P, N	2	✓	✓							
16	MW16A	21/02/2020	W	P, N	2	✓	✓							
			W	P, N		✓	✓							
			W	P, N		✓	✓							
			W	P, N		✓	✓							
			W	P, N		✓	✓							
			W	P, N		✓	✓							
			W	P, N		✓	✓							
			W	P, N		✓	✓							
			W	P, N		✓	✓							
				TOTAL	32									

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.

Appendix D: Aquatic Macroinvertebrate Data

DPM19015 - Middlemount Coal Mine Southern Extension Project - Wet season 2020

Sample picked by			DM	CP	DM	CP	DM	CP	DM	CP
Date sampled			18/02/2020	18/02/2020	19/02/2020	19/02/2020	18/02/2020	18/02/2020	18/02/2020	18/02/2020
Sample processed by			CP	CP	CP	CP	CP	CP	CP	CP
Date processed			27/02/2020	27/02/2020	27/02/2020	27/02/2020	27/02/2020	27/02/2020	27/02/2020	27/02/2020
Site name			R1	R1	R2	R2	R3	R3	R4	R4
Habitat type	**SIGNAL 2**	**AUSRIVAS**	**EDGE**	**BED**	**EDGE**	**BED**	**EDGE**	**BED**	**EDGE**	**BED**
ph. Porifera	4	IA019999								
cl. Hydrozoa										
Clavidae	3	IB029999								
Hydridae	2	IB019999								
ph. Nematoda	3	II999999								
ph. Nemertea	3	IH999999								
ph. Nematomorpha	6	IJ999999								
Gordiidae	5	IJ019999								
ph. Platyhelminthes										
Dalyelliidae										
Dugesiidae	2	IF619999								
Provorticidae										
cl. Temnocephalidea	5	IF419999								
s.c. Hirudinea										
Erpobdellidae	1	LH059999								
Glossiphoniidae	1	LH019999								
Hirudinidae	4	LH999999								
ph. Annelida										
s.c. Oligochaeta	2	LO999999								
cl. Bivalvia										
Corbiculidae	4	KP029999								
Hyriidae	5	KP019999								
Sphaeriidae	5	KP039999								
cl. Gastropoda										
Ancylidae	4	KG069999								
Bithyniidae	3	KG039999								
Glacidorbidae	5	KG099999								
Hydrobiidae	4	KG029999								
Lymnaeidae	1	KG059999								
Physidae	1	KG089999								
Planorbidae	2	KG079999			6		2			
Thiaridae	4	KG049999								
Viviparidae	4	KG019999								
cl. Arachnida										
s.c. Acarina	6	MM999999		1	1	2	1			
o. Araneae	-	-								
s.c. Branchiura	1	OK999999								
o. Cladocera	-	OG999999		20	5	47	5	35	1	23
s.c. Copepoda	-	OJ999999	4	15	3	37	6	6	5	15
o. Conchostraca	1	OF999999								
cl. Ostracoda	-	OH999999		3	2	1	6	1		3
o. Amphipoda										
Corophiidae	4	OP059999								
Hyalidae	3	-								
Paramelitidae	4	OP069999								
Talitridae	3	OP019999								
o. Isopoda										
Cirolanidae	2	OR129999								
Oniscidae	2	OR259999								
Sphaeromatidae	1	OR139999								
su.o. Syncarida										
Psammaspididae	-	ON059999								
o. Decapoda										
Atyidae	3	OT019999								
Palaemonidae	4	OT029999	5		5					

Parastacidae	4	OV019999					1			
Gecarcinucidae	3	OX519999	4		2	1	3		2	2
s.c. Collembola	1	QA999999							1	
o. Lepidoptera										
Crambidae	2	QL999999								
o. Megaloptera										
Corydalidae	7	QM019999								
Sialidae	5	QM029999								
o. Neuroptera										
Sisyridae	3	QN059999								
o. Coleoptera										
Carabidae	3	QC059999								
Chrysomelidae	2	QCAH9999								
Curculionidae	2	QCAN9999								
Dytiscidae	2	QC099999	1	4	5	12	5	5	4	
Elmidae	7	QC349999								
Georissidae	-	-								
Gyrinidae	4	QC109999								
Haliplidae	2	QC069999								
Heteroceridae	1	QC369999								
Hydraenidae	3	QC139999	9	1	6	1	3	1	9	
Hydrochidae	4	QCAO9999	1		1				1	
Hydrophilidae	2	QC119999	7						1	
Hygrobiidae	1	QC079999								
Limnichidae	4	QC359999								
Nanophyidae	3	-								
Noteridae	4	QC089999	2		2		1			
Psephenidae	6	QC379999								
Ptilodactylidae	10	QC399999								
Scirtidae	6	QC209999								
Spercheidae	2	-	1		2				2	
Sphaeriusidae	7	-								
Staphylinidae	3	QC189999								
o. Diptera										
Athericidae	8	QD229999								
Blephariceridae	10	QD049999								
Ceratopogonidae	4	QD099999	1	1			1		2	
Chaoboridae	2	QD059999				1				
s.f. Aphroteniinae	8	QDAA9999								
s.f. Chironominae	3	QDAJ9999	4	1	16	1	5	8	4	1
s.f. Orthocladiinae	4	QDAF9999								
s.f. Tanypodinae	4	QDAE9999	4	2	7	3	3	12	3	3
Corethrellidae	-	-								
Culicidae	1	QD079999				1				1
Dixidae	7	QD069999								
Dolichopodidae	3	QD369999								
Empididae	5	QD359999								
Ephydridae	2	QD789999								
Muscidae	1	QD899999								
Pelecorhynchidae	10	QD209999								
Psychodidae	3	QD129999								
Sciomyzidae	2	QD459999								
Simuliidae	5	QD109999								
Stratiomyidae	2	QD249999								
Syrphidae	2	QD439999								
Tabanidae	3	QD239999								
Tanyderidae	6	QD039999								
Thaumaleidae	7	QD119999								
Tipulidae	5	QD019999								
o. Ephemeroptera										
Ameletopsidae	7	QE049999								
Baetidae	5	QE029999	1			4		1	3	
Caenidae	4	QE089999		1						
Leptophlebiidae	8	QE069999								

Teloganodidae	9	QE079999								
o. Hemiptera										
Aphelocheiridae	-	-								
Belostomatidae	1	QH629999								
Corixidae	2	QH659999								
Dipsocoridae	-	-								
Gelastocoridae	5	QH649999								
Gerridae	4	QH579999	5		5		4		5	
Hebridae	3	QH539999								
Hydrometridae	3	QH549999	2		1					
Leptopodidae	-	QH589999								
Mesoveliidae	2	QH529999								
Micronectidae	2	-	14	19	5	5	5			11
Naucoridae	2	QH669999								
Nepidae	3	QH619999								
Notonectidae	1	QH679999	3	1		2		2		
Ochteridae	2	QH639999	1							
Pleidae	2	QH689999								
Saldidae	1	QH609999								
Veliidae	3	QH569999	6		13		2		1	
s.o. Zygoptera										
Argiolestidae	5	-								
Calopterygidae	-	QO109999								
Chlorocyphidae	-	-								
Chorismagrionidae	-	QO189999								
Coenagrionidae	2	QO029999	1		1					
Diphlebiidae	6	QO099999								
Hemiphlebiidae	-	QO019999								
Isostictidae	3	QO039999			1					
Lestidae	1	QO059999								
Lestoideidae	9	QO069999								
Platycnemididae	4	QO049999								
Synlestidae	7	QO089999								
s.o. Epiprocta										
Aeshnidae	4	QO129999	1							
Archipetaliidae	-	QO199999								
Austrocorduliidae	10	QO279999								
Austropetaliidae	-	QO209999								
Brachytronidae	-	-								
Cordulephyidae	5	QO289999								
Corduliidae	5	QO169999								
Gomphidae	5	QO139999								
Gomphomacromiidae	-	QO249999								
Hemicorduliidae	5	QO309999	6		4	3	1	2		
Libellulidae	4	QO179999	6	1	4		6		1	
Lindeniidae	3	QO229999								
Macromiidae	8	QO269999								
Oxygastridae	-	QO299999								
Petaluridae	-	QO159999								
Pseudocorduliidae	-	QO259999								
Synthemistidae	2	QO239999								
Telephlebiidae	9	QO219999								
o. Plecoptera										
Gripopterygidae	8	QP039999								
o. Trichoptera										
Antipodoeciidae	8	QT169999								
Atriplectididae	7	QT239999								
Calamoceratidae	7	QT249999								
Calocidae	9	QT189999								
Conoesucidae	7	QT159999								
Dipseudopsidae	9	QT269999								
Ecnomidae	4	QT089999								
Glossosomatidae	9	QT029999								
Helicophidae	10	QT199999								

Helicopsychidae	8	QT069999								
Hydrobiosidae	8	QT019999								
Hydropsychidae	6	QT179999								
Hydroptilidae	4	QT039999								
Kokiriidae	3	QT209999								
Leptoceridae	6	QT259999	1	2		1				
Limnephilidae	8	QT109999								
Odontoceridae	7	QT229999								
Oeconesidae	8	QT129999								
Philopotamidae	8	QT049999								
Philorheithridae	8	QT219999								
Plectrotarsidae	-	QT119999								
Polycentropodidae	7	QT079999								
Psychomyiidae	-	QT099999								
Stenopsychidae	-	QT059999								
Tasimiidae	8	QT139999								
Summary										
Taxa count			**24**	**14**	**22**	**16**	**18**	**10**	**16**	**8**
No. Individuals			**90**	**72**	**97**	**122**	**60**	**73**	**45**	**59**
PET taxa			**2**	**2**	**0**	**2**	**0**	**1**	**1**	**0**
Plecoptera			**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Ephemeroptera			**1**	**1**	**0**	**1**	**0**	**1**	**1**	**0**
Trichoptera			**1**	**1**	**0**	**1**	**0**	**0**	**0**	**0**
SIGNAL2 average (Family)			**3.30**	**3.55**	**3.32**	**3.31**	**3.53**	**3.29**	**3.14**	**2.60**
Taxa with SIGNAL2 scores			**23**	**11**	**19**	**13**	**15**	**7**	**14**	**5**
Tolerant taxa (≤3)			**12**	**5**	**11**	**8**	**7**	**4**	**8**	**4**
% tolerant taxa			**52**	**45**	**58**	**62**	**47**	**57**	**57**	**80**