Appendix O

Mine development aquatic ecology assessment

REGIS RESOURCES LTD

McPhillamys Gold Project

Aquatic Ecology Assessment

Prepared for LFB Resources NL
August 2019

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McPhillamys Gold Project

Aquatic Ecology Assessment

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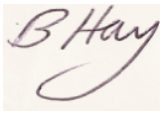

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23 August 2019

Approved by

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23 August 2019

Executive summary

ES1 Introduction

LBF Resources NL, a 100% owned subsidiary of Regis Resources Limited (Regis) is seeking development consent for the construction and operation of the McPhillamys Gold Project (McPhillamys Project), a greenfield open cut gold mine ('mine development') and water supply pipeline ('pipeline development') in the central west of New South Wales (NSW). The mine development is approximately 8 km northeast of Blayney within the upper reaches of the Belubula River catchment, and the greater Lachlan River catchment. The McPhillamys Project will include development of an open cut gold mine, placement of waste rock into a waste rock emplacement, construction and operation of a conventional carbon-in-leach processing facility, construction and use of an engineered tailings storage facility (TSF), and construction and operation of associated mine infrastructure.

A number of State and Commonwealth pieces of legislation apply to the proposed development, with the NSW Department of Planning and Environment (DPE) requiring the Environmental Assessment Requirements (EARs) set for the McPhillamys Project to be addressed. The EARs require an assessment of ('assessment requirements') the likely impacts of the McPhillamys Project on aquatic ecology and key fisheries issues, including the aquatic biodiversity and key fish habitats of 3rd order tributaries and above, as defined by the Strahler stream classification system.

ES1.1 Aim and objectives

The aquatic ecology assessment was undertaken to provide the Department of Primary Industries – Fisheries Division (DPI Fisheries) with information regarding the aquatic and riparian biodiversity values of the Belubula River, and the potential impacts resulting from development of the McPhillamys Project. This report outlines an assessment of the likely impacts of the mine development on aquatic ecology and key fisheries issues, including Aquatic Biodiversity and Key Fish Habitats. Specifically, to outline the likely impacts of the mine development on the following items:

- '…aquatic ecology and key fisheries issues, including aquatic biodiversity and key fish habitats…'; and
- '…riparian land…'.

Therefore, the aim of the aquatic ecology assessment was to determine aquatic and riparian vegetation condition, relative to the mine development, in accordance with the assessment requirements. The specific objective of the aquatic ecology assessment was to undertake an assessment of waterways to determine whether they meet:

- the definition of 'key fish habitat'; and/or
- habitat for threatened species and ecological communities.

The content of the aquatic ecology assessment is limited to aquatic and riparian habitat and species, and does not address terrestrial ecology. Riparian vegetation is defined by the DPI Fisheries as "The plants growing on the water's edge, the banks of rivers and creeks and along the edges of wetlands…", and consist of trees, shrubs, grasses and/or vines across a number of structural components.

In accordance with Section 221ZV of the FM Act, and following consultation with DPI Fisheries, a summary of the following has also been provided:

- potential direct and indirect impacts on aquatic and riparian ecology, including threatened species, populations or ecological communities;
- recommended mitigation and management strategies; and
- potential ecological offset approaches.

ES2 Results and discussion

ES2.1 Desktop review

Results of the database searches and literature review indicated that one endangered ecological community (EEC) is associated with the Belubula River; the FM Act-listed Lachlan River EEC, which commences downstream of Carcoar Dam (approximately 20 km southwest of the mine development), and includes the Great Cumbung Swamp, located more than 500 km west-southwest of the mine development. This EEC protects vertebrate and invertebrate fauna within all waterways associated with the lowland catchment of the Lachlan River. Carcoar Dam is currently documented as supporting, predominantly through restocking programs, the native Golden Perch (*Macquaria ambigua*), and the Silver Perch (*Bidyanus bidyanus*; listed under the FM Act as Vulnerable) and the Murray Cod (*Maccullochella peelii*; listed under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) as Vulnerable). No riparian communities within, or adjacent to, the mine development are listed under any State or Commonwealth legislation.

A previous assessment aimed to validate stream order in the upper reaches of the surface water catchment, within the vicinity of the mine development but excluding the wider Belubula River catchment. This assessment demonstrated that a high number of mapped tributaries do not meet the definition of a minor stream, particularly within the headwater of the catchment. This is attributed to highly modified landscapes associated with clearing for agriculture and grazing, as well as forestry applications. Only two identifiable flow pathways were able to be mapped. This is particularly relevant to the aquatic ecology assessment as a lack of defined banks, incised channels and fringing vegetation usually result in degraded habitat, reduced habitat complexity and poor water quality. As a result, there appears to be minimal water flow in the Belubula River and associated tributaries during dry conditions, within the mine development, with increasing bank erosion and incision noted between assessments. A lack of connectivity between sites is typical of this area during baseflow (low-flow) conditions, attributed to the degree of landscape modification currently experienced by the broader upstream area of the Belubula River. A number of locations were also documented by Regis that demonstrated the existing fragmentation of local waterways. It is also unlikely that this area will hold surface water for any prolonged period, reducing the likelihood that the majority of waterways would provide suitable habitat to support migration and breeding among local populations of resident native aquatic fauna. However, the potential also exists for declines to be attributed, in part, to historic below-average rainfall.

A total of five fish species of conservation significance were identified in the desktop review as having the potential to occur within, or adjacent to the mine development; Southern Purple-spotted Gudgeon (*Mogurnda adspersa*), Trout Cod (*Maccullochella macquariensis*), Murray Cod (*Maccullochella peelii*), Macquarie Perch (*Macquaria australasica*) and the Eel-tailed Catfish (*Tandanus tandanus*; Murray-Darling Basin population). These species have been historically recorded within the Lachlan, Murrumbidgee, Macquarie, Darling and Murray rivers of the Murray Darling Basin. However, it is unlikely that they would occur within the mine development. The larger pelagic species (Trout Cod, Murray Cod, Macquarie Perch) are unlikely to occur within waterways of this magnitude due to the level of disturbance and a lack of connectively in the vicinity of the mine development. In addition, DPI Fisheries-provided threatened species distribution mapping shows that the Eel-tailed Catfish and the Southern Purple-spotted Gudgeon are currently largely absent from the waterways immediately adjacent to the mine development.

In terms of local riparian flora, three species were considered to be of conservation significance and have the potential to occur in the riparian zone; Black Gum (*Eucalyptus aggregata*), *Philotheca ericifolia* (family Rutaceae) and Austral Toadflax (*Thesium austral*). However, existing ecological assessments indicate that it is unlikely that *Philotheca ericifolia* and Austral Toadflax would a occur within, or adjacent to, the mine development. While Black Gum prefers the lowest areas of the landscape, occurring on alluvial soils, cold, poorly drained flats and hollows adjacent to creeks and small rivers, targeted searches did not identify this species within the mine development.

ES2.2 Field survey results

The field survey was undertaken within, and downstream of, the mine development, and includes the junctions of the Belubula River and the Mid Western Highway, and the Belubula River and Newbridge Road. A total of 15 sites within four waterways, and their associated riparian zones, were assessed for key fish habitat and riparian vegetation condition, respectively, throughout the Belubula River and associated tributaries. Each waterway assessed had previously been ranked according to the Strahler method of stream ordering. Key fish habitat sensitivity was assessed by assigning a 'waterway type', while the functionality of the waterway as fish habitat was assessed by assigning a 'waterway class', in accordance with DPI Fisheries *Policy and guidelines for fish habitat conservation and management*. Flowing water was recorded from five sites during the field survey, assessed as having both highly sensitive and moderately sensitive (waterway type), and moderate (waterway class) key fish habitats. However, it is unlikely that the waterway supports species of conservation significance due to livestock-associated erosion, with grazing noted as a contributing factor in the deterioration in aquatic habitat condition, consistent with previous surveys. As a result of this assessment the majority of the sites were determined to be unlikely to contain key fish habitat, with only one site (BR-03) located within the mine development along the Belubula River classified as Type 1-highly sensitive key fish habitat and Class 2-moderate key fish habitat. The majority of the aquatic and riparian vegetation observed within, and adjacent to, the waterway comprised exotic taxa; however, this vegetation may still provide structures that contribute to functional in-stream fish habitat.

Overall, riparian condition was considered poor, with riparian zones generally degraded and impacted to some degree by agriculture and livestock, and exhibiting erosive gully features within the waterway channel and along the banks. A defined bank was absent at some sites within the Belubula River and the majority of sites displayed little to no native vegetation cover, with introduced willow species dominant. The understorey at the majority of sites was characterised by exotic grasses along the bank and within the waterway channel, and usually comprised other weeds including blackberry (*Rubus fruticosus*), which is listed as a weed of national significance. Although exotic plants were dominant over native vegetation within the riparian zone, there was some habitat continuity at a small number of the sites which may provide vegetative cover and structural complexity, potentially providing key fish habitat. Some land management measures were noted, with fencing and rehabilitation of the waterway observed as a result of gully erosion along the bed and banks. However, currently, there are limited mitigation measures in place within the riparian zone to restrict impacts from agriculture or livestock, meaning that the limited potential habitat is likely to be subject to ongoing pressures without intervention.

ES3 Environmental receptors, impacts and avoidance

ES3.1 Environmental receptors

The construction of the McPhillamys Project is expected to require the mining of an open cut pit and the construction of a waste emplacement area, water storage/sediment basins, a TSF and associated infrastructure. The construction of the TSF will occur at the headwater of the Belubula River, while the construction of other infrastructure will occur across a number of associated minor tributaries. Based on the findings of the aquatic ecology assessment, the primary environmental receptors identified in relation to potential impacts associated with mine development comprise:

- water and sediment quality, downstream of construction areas;
- key fish habitat;
- aquatic biodiversity (eg algae, macrophytes, aquatic invertebrates and aquatic vertebrates); and
- native plants inhabiting the riparian zone.

ES3.2 Potential impacts

Overall, it is considered unlikely that existing habitat within the Belubula River and associated tributaries would support species of conservation significance. This is attributed to high levels of existing environmental degradation and a lack of on-going mitigation or management across the local region. Therefore, existing habitat condition, in conjunction with the current distribution of threatened species, indicates that there is not expected to be a significant ecological risk as a result of mine development. However, the potential does exist for direct and indirect impacts to environmental receptors to occur along the Belubula River and associated tributaries, as a result of the proposed mine development, listed below:

- Potential direct impacts:
  - decrease in short-term water and sediment quality (impacting aquatic biodiversity);
  - aquatic and riparian habitat removal and habitat fragmentation (impacting key fish habitat); and
  - reduction or cessation in surface water flow between the headwater of the Belubula River and Trib A (impacting key fish habitat).
- Potential indirect impacts:
  - decrease in medium-term water and sediment quality (impacting aquatic biodiversity);
  - breach of water quality objectives (ie elevated salinity and/or metal concentrations) as a result of seepage to groundwater, unplanned discharge to surface water, runoff, or failure of the surface water management system (impacting aquatic biodiversity);
  - potential for reduction in surface water flow (impacting key fish habitat);
  - altered hydrology within the Belubula River during high-flow events (impacting key fish habitat);
  - erosion, siltation and degradation of the riparian zone, including an increase in instability of waterway banks and beds (impacting key fish habitat and aquatic biodiversity);
  - reduced recruitment of native riparian plants, including potential loss of conservation significant vegetation and habitat (impacting riparian biodiversity); and
  - contribution to key threatening processes (impacting key fish habitat and aquatic biodiversity).

Construction of the TSF will remove one site characterised as having sufficient features to warrant being classified as Class 2-moderate key fish habitat as well as other areas of aquatic and riparian habitat. However, there is currently little connectivity areas of aquatic habitat within the mine disturbance footprint during low-flow conditions, and it is unlikely that surface water will remain a period sufficient to support resident native aquatic fauna. With regard to direct impacts, habitat removal and fragmentation within the mine development has been substantially reduced since the preparation of the Preliminary Environmental Assessment (PEA), with Trib A and sections of the Belubula River, downstream of Trib A, removed from the disturbance footprint. Trib A has been observed to provide substantial surface water input during high rainfall/high flow conditions, while areas downstream of the confluence of Trib A and the Belubula River have also been observed to hold surface water for longer periods in comparison to areas on the Belubula upstream of the confluence. Overall, it is considered unlikely that the mine development would impact extensively on local habitat loss and fragmentation.

In terms of indirect impacts, there is the potential that surface water flow to Carcoar Dam and other downstream areas will decrease as a result of construction of the TSF and associated water storage facilities. This may result in decreased surface water availability and fish passage impediment; in particular, the conservation significant fish species within the Carcoar Dam, the Lachlan River EEC, and the Great Cumbung Swamp wetlands. However, the reduction in flow will occur at the headwater of the Belubula River, resulting in a 4% reduction in median annual flow to Carcoar Dam, resulting in a negligible impact to flows received by Carcoar Dam. This, in addition to the already existing lack of local connectivity during low-flow conditions, the distinct absence of species of conservation significance within the Belubula River and associated tributaries upstream of Carcoar Dam, and the physical barrier (Carcoar Dam) between the mine development and known areas of conservation significance means impacts will be negligible.

With regard to the riparian zone, erosion and degradation leading to instability of waterway banks and beds, and an increase in sedimentation may occur over the short to medium-term due to construction and operation of the mine development. However, a number of management and mitigation plans and monitoring programs will be established, reducing the likelihood of impact occurrence. While reduced recruitment of native riparian plants has the potential to occur, the loss of conservation significant riparian vegetation and habitat is unlikely due to its absence within the local area. It is also unlikely that the riparian zone currently provides habitat to other threatened flora or fauna species, and comprises mostly exotic taxa. No EPBC Act-listed threatened species and communities, or Ramsar wetlands of international importance ('Ramsar wetlands') identified in the aquatic ecology assessment have been documented as occurring within the mine development, and therefore are unlikely to be impacted as a result.

ES4 Summary

There is unlikely to be any significant impact, as a result of the mine development, to threatened species, populations or ecological communities listed under the FM Act or EPBC Act, within the aquatic or riparian environments of the Belubula River and associated tributaries, upstream of Carcoar Dam. It is considered that sufficient in-field survey has been undertaken within the vicinity of the mine development, and that additional survey is unlikely to yield suitable habitat or taxa of conservation significance. Furthermore, assessed habitat, and local conditions in general, are highly degraded and influenced by pastoralism and agricultural uses, limiting their functionality as key fish habitat. In terms of habitat between the mine development and the Carcoar Dam, connectivity may occur during high flow events. However, it is considered unlikely that the system provides a high level of connectivity during low-flow conditions, and this, in conjunction with the highly disturbed condition of the aquatic environment, indicate that existing habitat is unlikely to be suitable in terms of key fish habitat and as habitat for threatened species. With regard to surface water flow, downstream of the mine development, a reduction in flow will occur at the headwater of the Belubula River, resulting in a 4% reduction in median annual flow to Carcoar Dam, a negligible impact that is unlikely to affect flows received by the Carcoar Dam. In addition, a number of monitoring and management plans will be development and implemented to reduce the likelihood of impacts occurring to water and sediment quality, including erosion and sedimentation. Overall, it is unlikely that direct and indirect impacts resulting from the mine development will contribute to exacerbation of key threatening processes within the broader area.

ES5 Recommendations

Regis is currently considering a range of biodiversity offset and habitat enhancement initiatives to ensure biodiversity values are maintained or improved in the long-term. Relevant to aquatic and riparian ecology, several recommendations are provided for consideration, providing guidance on future research, monitoring (where applicable) and environmental management including:

- Ongoing monitoring and assessment of mine development impacts on aquatic and riparian ecology.
- Implement appropriate aquatic rehabilitation programs (in conjunction with existing landowners) along waterway banks and within the riparian zone, consisting of weed management, native vegetation planning, erosion control/prevention, and fencing of semi-permanent pools and/or springs.
- Where possible, existing dams, weirs or other in-stream structures, not critical to mine development function, should be removed to increase the potential for movement of aquatic fauna.
- Implement an aquatic and riparian zone rehabilitation program.
- Consider developing site-specific water quality criteria for use in future monitoring programs.
- Continue consultation with the DPI Fisheries to determine the most appropriate aquatic habitat offsets, in alignment with *NSW Biodiversity Offsets Policy for Major Projects* and *Biodiversity Offsets Policy for Major Projects Fact sheet: Aquatic biodiversity*.
- Engage with stakeholders to promote catchment improvement programs for the Belubula River, above Carcoar Dam.

ES6 Ecological offsets

DPI Fisheries has indicated that an aquatic ecology offset strategy will be required as part of the McPhillamys Project in accordance with *Biodiversity Offsets Policy for Major Projects Fact sheet: Aquatic biodiversity*. In terms of aquatic biodiversity, it is acknowledged that an offset strategy should be implemented:

- within the Belubula River catchment;
- within "like for like" habitat;
- within the same or a similar habitat in the same catchment that is more threatened than the habitat being impacted on; and
- as part of an offset site, as versus implementing supplementary measures.

In the event that the above criteria cannot be met, then funds may be provided towards implementing supplementary measures which provide additional flexibility in fulfilling offset requirements. These may include:

- implementing actions outlined in relevant threatened species recovery plans or Priorities Action Statement in the absence of threatened species recovery plans;
    - eg Priorities Action Statement – Actions for the Southern Purple Spotted Gudgeon.
- Implementing actions that contribute to threat abatement plans;
    - eg Threat Abatement Plan – large woody debris.
- undertaking biodiversity research and survey programs identified by the DPI Fisheries; and/or
- rehabilitating degraded aquatic habitat.

In the context of the McPhillamys Project and, due to the high level of habitat disturbance and fragmentation currently existing within the Belubula River catchment, it is likely that supplementary measures would form a key part of any offset strategy. For example, Regis could provide funding towards existing habitat mapping programs within the broader region (eg below Carcoar Dam), undertake aquatic and riparian habitat rehabilitation along the Belubula River, and/or remove existing barriers to fish passage along the Belubula River, not critical to mine development function. In the event that a monetary contribution is proposed in place of offsets occurring within the same or a similar habitat to that being impacted, then the area of habitat loss within the mine development ('disturbance footprint') would be calculated for impacted waterways.

The DPI (2014) requires that a minimum 2:1 offset occurs for Type 1 to Type 3 key fish habitats to redress both the direct and indirect impacts of development. Within waterways assessed by EMM, approximately 1.8 km of Type 1 highly sensitive key fish habitat and approximately 0.4 km of Type 3 minimally sensitive key fish habitat was identified within the disturbance footprint (Figure 6.1). This key fish habitat will be subject to direct impacts as a result of the placement of the TSF (Figure 1.3). It should be noted that these lengths do not directly relate to the area calculations required by the DPI (2014). Regis will therefore carry out further field verification (ie ground truth stream widths) and/or spatial data analysis to quantify the areas of key fish habit to be removed in consultation with DPI Fisheries. In addition, it should be noted that:

- any offset strategy will be developed in consultation with the DPI Fisheries, and relevant technical staff, to determine whether on site improvement or contribution to priorities identified by DPI Fisheries is the preferred option; and
- the offset strategy will be developed following approval of the McPhillamys Project.

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1 Introduction

1.1 Project overview

LFB Resources NL, a 100% owned subsidiary of Regis Resources Limited (Regis), proposes to develop the McPhillamys Gold Project (McPhillamys Project), a greenfield open cut gold mine and water supply pipeline in central west NSW. The project application area is illustrated at a regional scale in Figure 1.1.

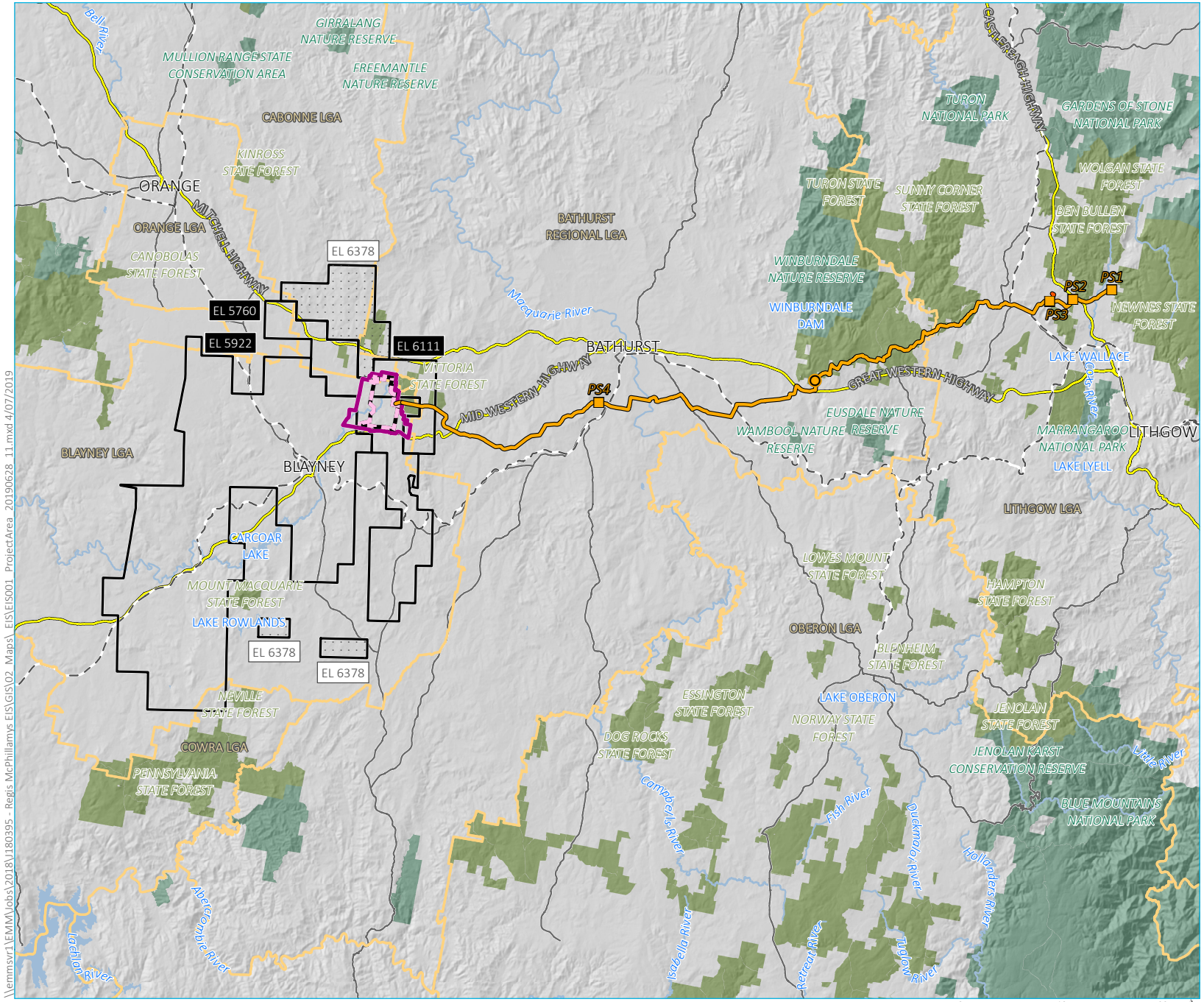
The project for which development consent is sought comprises two key components; the mine site where the ore will be extracted, processed and gold produced for distribution to the market (the mine development), and an associated water pipeline which will enable the supply of water from near Lithgow to the mine site (the pipeline development). The mine development is approximately 8 kilometres (km) north-east of Blayney, within the Blayney and Cabonne local government areas, and within the upper reaches of the Belubula River catchment, within the greater Lachlan River catchment (Figure 1.2).

EMM Consulting Pty Limited (EMM) was engaged by Regis to prepare an aquatic ecology assessment for the mine development component of the McPhillamys Project. The potential impacts on aquatic ecology associated with the pipeline development are addressed in a separate study by OzArk Environment and Heritage (refer to Appendix Y of the Environment Impact Statement for the McPhillamys Project). For the purposes of this report, the mine development component to which this assessment applies, is referred to as the project.

1.2 Project description

A detailed project description will be provided in the Environmental Impact Statement (EIS) currently being prepared for the McPhillamys Project; however, the key components (Figure 1.3), relevant to aquatic ecology and the mine development, are listed below:

- Development and operation of an open cut gold mine, comprising approximately one to two years of construction, approximately 10 years of mining and processing and a closure period (including the final rehabilitation phase) of approximately three to four years, noting there may be some overlap of these phases. The total project life for which approval is sought is 15 years.
- Development and operation of a single circular open cut mine with a diameter of approximately 1,050 metres (m) and a final depth of approximately 460 m, developed by conventional open cut mining methods encompassing drill, blast, load and haul operations.
- Construction and use of a conventional carbon-in-leach (CIL) processing facility with a processing rate of up to 7 Mtpa to produce up to 200,000 ounces per annum of product gold, comprising a run of mine (ROM) pad and crushing, grinding, gravity, leaching, gold recovery, tailings thickening, cyanide destruction and tailings management circuits.
- Placement of waste rock into a waste rock emplacement which will include encapsulation of material with the potential to produce a low pH leachate.
- Construction and use of an engineered tailings storage facility (TSF) to store tailings material.
- Construction and operation of associated mine infrastructure including buildings, workshops, ancillary features, internal roads, an explosives magazine and an on-site laboratory.
- Establishment and use of a site access road and intersection with the Mid Western Highway.
- Construction and operation of water management infrastructure, including raw water storage facilities, clean water and process water diversions and storages, and sediment control infrastructure.



KEY

- Mine development project area (2,513.47 ha)
- Mining lease application area (1,812.99 ha) (Note: boundary offset for clarity)
- Pressure reducing system
- Pumping station facility
- Pipeline corridor
- Pipeline corridor (Blowdown Pond)

Existing environment

- Rail line
- Primary road
- Arterial road
- River
- Waterbody
- NPWS reserve
- State forest
- Local government area

Exploration lease boundaries (of interest)

- Held by LFB Resources NL (Regis)
- Held by others

Source: EMM (2019); Regis Resources (2019); DPE (2018); DFSI (2017); GA (2011)

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GDA 1994 NSW Lambert

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Regional location of the McPhillamys Project

McPhillamys Gold Project
Aquatic ecology assessment
Figure 1.1

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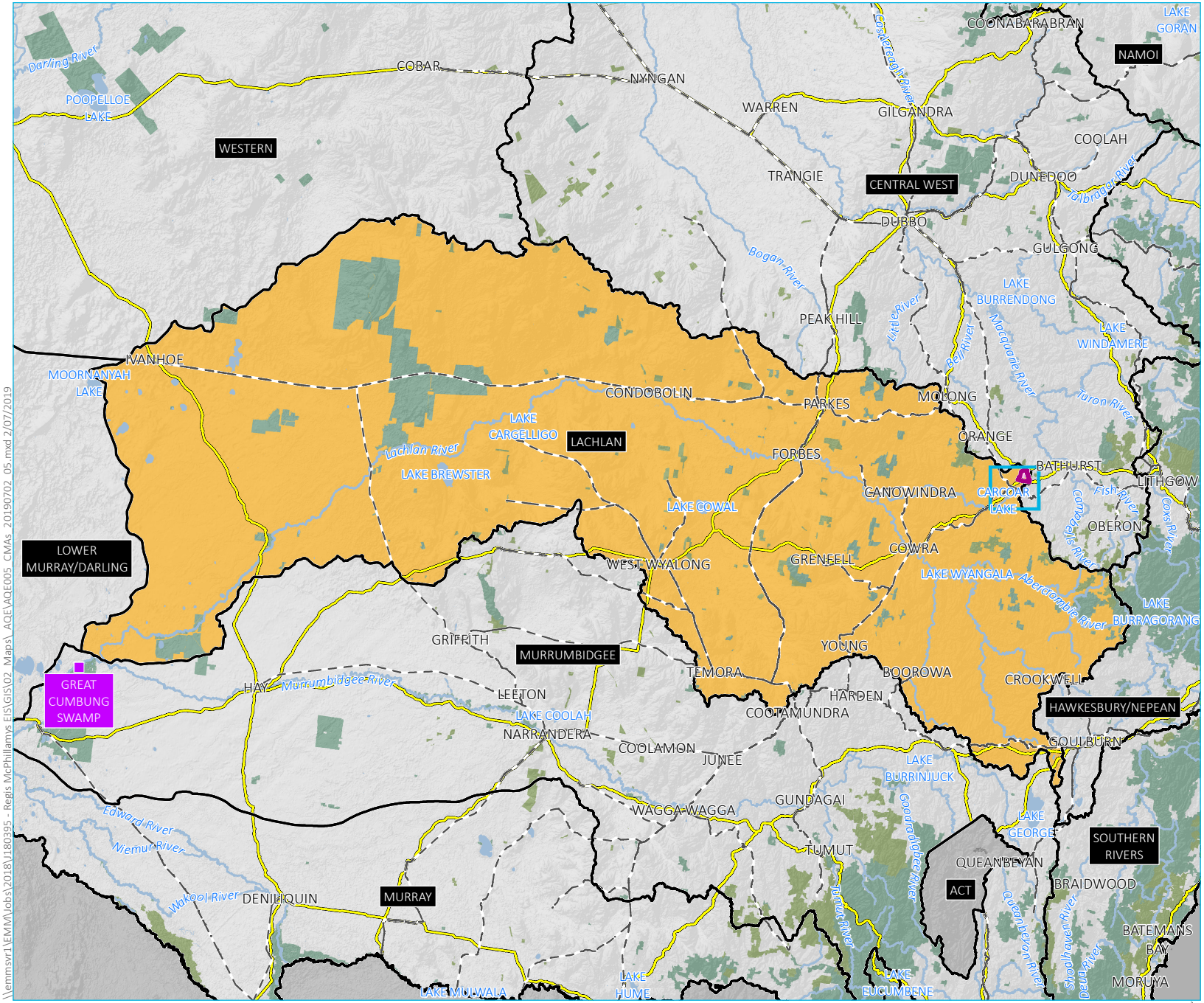
EMM creating opportunities



Source: EMM (2019); Regis Resources (2019); DFSI (2017); GA (2011); DIPNR (2006)

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Catchments within the vicinity of the mine development

McPhillamys Gold Project
Aquatic ecology assessment
Figure 1.2

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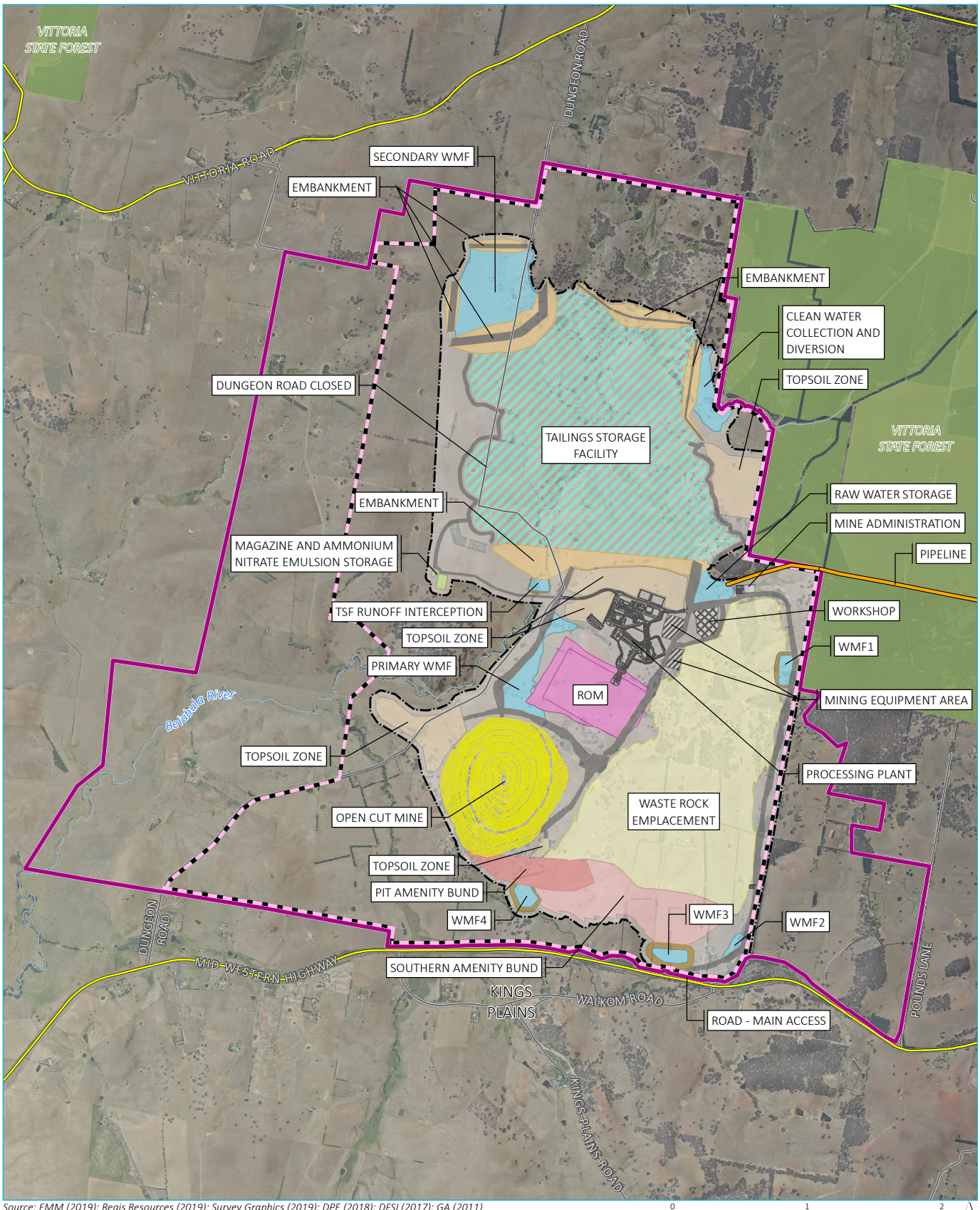
EMM creating opportunities



Source: EMM (2019); Regis Resources (2019); Survey Graphics (2019); DPE (2018); DFSI (2017); GA (2011)

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KEY

Project application area

Mine development project area (2,513.47 ha)

Mining lease application area (1,812.99 ha) (Note: boundary offset for clarity)

Disturbance footprint

Pipeline corridor

Project general arrangement

Plant layout

Road

Water management facility (WMF)

Sediment basin structure

Existing environment

Main road

Local road

Belubula River

State forest

Location of mine development infrastructure

McPhillamys Gold Project
Aquatic ecology assessment
Figure 1.3

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EMM creating opportunities

1.3 Regulatory requirements

NSW legislation relevant to the assessment of aquatic and riparian ecology of the mine development comprises:

- *Environmental Planning and Assessment Act 1979* (EP&A Act);
- *Fisheries Management Act 1994* (FM Act); and
- *Water Management Act 2000* (WM Act).

Under the EP&A Act, for projects classified as a 'state significant development' (SSD), proponents must prepare an EIS to address the Department of Planning and Environment's (DPE) Environmental Assessment Requirements (EARs). The EARs for the McPhillamys Project were issued on the 24th July 2018 and revised on the 19th December 2018. The EARs identify matters which must be addressed in the EIS and essentially form the EIS 'terms of reference'. The EARs require an assessment of ('assessment requirements') the likely impacts of the McPhillamys Project on aquatic ecology and key fisheries issues, including aquatic biodiversity and key fish habitats.

To inform the preparation of the EARs, the DPE invited other regulatory departments to recommend matters to be addressed in the EIS. The Department of Primary Industries – Fisheries Division (DPI Fisheries), who administer the FM Act, conveyed concerns that the McPhillamys Project includes '…an extensive loss of key fish habitat in the Belubula River'. A primary objective of the FM Act is to '…conserve, develop and share the fishery resources of the State for the benefit of present and future generations', in particular to:

- conserve fish stocks and key fish habitats;
- conserve threatened species, populations and ecological communities of fish and marine vegetation; and
- promote ecologically sustainable development, including the conservation of biological diversity.

The DPI Fisheries (2013) defines key fish habitat using a combination of habitat sensitivity (waterway type) and water classification (waterway class), with 3rd order tributaries and above (as defined by Strahler (1952)) usually considered key fish habitat requiring conservation and management. Accordingly, the DPI Fisheries have advised that investigation into the aquatic habitat of this area is required due to the proposed development of the TSF across 3rd order and 4th order tributaries associated with the Belubula River, as defined by Strahler (1952). In addition, the potential exists for habitat suitable for the Southern Purple-spotted Gudgeon (*Mogurnda adspersa*) and the Murray-Darling Basin population of Eel-tailed Catfish (*Tandanus tandanus*) to occur within, and downstream of, the open cut mine development.

As a result, the assessment requirements prescribe that an assessment of the likely impacts of the development on aquatic ecology and key fisheries issues, including aquatic biodiversity and key fish habitats, and a detailed description of the proposed regime for minimising, managing and reporting on the biodiversity impacts of the development be undertaken. Consequently, the assessment of impacts on aquatic biodiversity, and subsequent potential offsets, must be undertaken in accordance with *NSW Biodiversity Offsets Policy for Major Projects Fact sheet: Aquatic biodiversity* (Department of Primary Industries, 2014). The policy notes that '*Offset sites can include the same or a similar habitat in the same catchment that is more threatened than the habitat being impacted on*'. In addition, the EIS should also address impacts including dams, waterway crossings and barriers to fish passage, threatened species, populations and ecological communities, and riparian buffer zones. A summary of the above requirements, as well as a document or section reference, is provided in Table 1.1.

As the McPhillamys Project will be classified as an SSD, pursuant to Section 4.41 of the EP&A Act, it will be exempt from approvals usually required for assessment of a controlled activity under s 91 of the WM Act. However, the WM Act provides physical definition of a waterway, and other waterbodies, pertinent to this assessment:

> 'watercourse means a river, creek or other natural stream of water (whether modified or not) flowing in a defined channel, or between banks, notwithstanding that the flow may be intermittent or seasonal or the banks not clearly or sharply defined, and includes –
>
> (a) a dam that collects water flowing in any such stream; and
>
> (b) a lake through which water flows; and
>
> (c) a channel into which the water of any such stream has been diverted; and
>
> (d) part of any such stream; and
>
> (e) the floodplain of any such stream –…'

Table 1.1 Summary of the assessment requirements relevant to aquatic and riparian ecology

Regulator	Requirement	Document (Section) Reference
DPE	An assessment of the likely impacts of the development on aquatic ecology and key fisheries issues, including aquatic biodiversity and key fish habitats.	Aquatic Ecology Assessment (**Section 5**)
DPE	A detailed description of the proposed regime for minimising, managing and reporting on the biodiversity impacts of the development.	Aquatic Ecology Assessment (**Section 6**) EIS / Subsequent Management Plans
DPI Fisheries	The EIS should include an assessment of the impacts on aquatic biodiversity and the requirement for aquatic biodiversity offsets.	Aquatic Ecology Assessment (**Section 5**, **Section 8**)
DPI Fisheries	The EIS should address impacts on key fish habitats (3rd order streams or larger under the Strahler stream order system) such as the Belubula River (Strahler 5th order stream), Trib F (Strahler 4th order stream), and an unnamed tributary (Strahler 3rd order stream).	Aquatic Ecology Assessment (**Section 5**)
DPI Fisheries	The EA should conduct an aquatic ecological assessment and address impacts to key fisheries-related issues including aquatic biodiversity; dams, waterway crossings and barriers to fish passage; threatened species, populations and ecological communities; and riparian buffer zones.	Aquatic Ecology Assessment (**Section 4**, **Section 5**)

Commonwealth legislation relevant to the aquatic ecology assessment includes the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), which provides a framework for protection of the Australian environment, including its biodiversity and its natural and culturally significant places. It also facilitates a more streamlined national environmental assessment and approvals process between the Commonwealth, and the States and Territories. Actions that are likely to have a significant impact on matters of national environmental significance (MNES) require approval from the Minister for the Environment and Energy. Of the nine MNES that are regulated by the EPBC Act, the following may be associated with the McPhillamys Project, and the aquatic ecology assessment aims to evaluate as to whether these MNES are applicable:

- listed threatened aquatic species and communities; and/or
- Ramsar wetlands of international importance ('Ramsar wetlands').

1.4 Aim and objectives

The aquatic ecology assessment was undertaken to identify the aquatic and riparian biodiversity values of the Belubula River, and the potential impacts resulting from development of the McPhillamys Project. This report outlines an assessment of the likely impacts of the mine development on aquatic ecology and key fisheries issues, including Aquatic Biodiversity and Key Fish Habitats. Specifically, to outline the likely impacts of the mine development on the following items:

- '…aquatic ecology and key fisheries issues, including aquatic biodiversity and key fish habitats…'; and
- '…riparian land…'.

Therefore, the aim of the aquatic ecology assessment was to determine aquatic and riparian vegetation condition, relative to the mine development, in accordance with the assessment requirements (Table 1.1). The assessment requirements also require identification of potential strategies for impact minimisation; provided in subsequent sections, and detailed further within the EIS and subsequent management plans. The specific objective of the aquatic ecology assessment was to undertake an initial assessment of waterways to determine whether they meet:

- the definition of 'key fish habitat' (Department of Primary Industries, 2013); and/or
- habitat for threatened species and ecological communities.

The following tasks were completed to address the aim and objectives of the aquatic ecology assessment:

- database searches and literature review, including work undertaken by EMM Consulting Pty Ltd (2018; 2019) and EnviroKey Pty Ltd (2014; 2017);
- collation of historic data (where available), drawing comparison where possible;
- an aquatic ecology field survey, including:
  - an assessment of key fish habitat and riparian condition using a combination of habitat sensitivity (waterway type) and water classification (waterway class);
  - cataloguing of detailed photographs of each waterway; and
  - an assessment of habitat for fish species, in particular the Southern Purple-spotted Gudgeon and the Eel-tailed Catfish.
- mapping of key fish habitat and/or suitable threatened species habitat; and
- preparation of an aquatic ecology assessment report to:
  - summarise the above information and assess the potential of the mine development to impact upon key fish habitat, either directly or indirectly; and
  - provide recommendations as appropriate.

The aquatic ecology assessment was undertaken within, and downstream of, the mine development, and includes the junctions of the Belubula River and the Mid Western Highway, and the Belubula River and Newbridge Road. The content of the aquatic ecology assessment is limited to aquatic and riparian habitat and species, and does not address terrestrial ecology. Riparian vegetation is defined by the DPI Fisheries as “The plants growing on the water's edge, the banks of rivers and creeks and along the edges of wetlands…”, and consist of trees, shrubs, grasses and/or vines across a number of structural components (ie groundcovers, understorey and canopy) (Department of Primary Industries, 2019).

EMM has ensured that the objectives have been addressed to a standard suitable for assessment by the DPE, following best practice and in accordance with relevant environmental and planning legislation summarised in Section 1.3. In addition, the aquatic ecology assessment has been undertaken in accordance with the assessment requirements, relevant DPI Fisheries guidance documents and advice, and Section 221ZV of the FM Act, where applicable.

2 Bioregional overview

2.1 Biogeographical context and land use

The South Eastern Highlands bioregion is bound by the Australian Alps and South Western Slopes bioregions to the south and west, respectively, and covers approximately 8,749,155 ha (NSW National Parks and Wildlife Service, 2003). Of this, 4,888,633 ha of the bioregion lies in New South Wales. Major urban centres within the bioregion include Orange, Bathurst and Lithgow to the north, Goulburn, Queanbeyan and Yass across central areas, and Cooma, Jindabyne and Bombala to the south (NSW National Parks and Wildlife Service, 2003). The Lachlan, Macquarie, Murray, Murrumbidgee, Shoalhaven and Snowy rivers also bisect the South Eastern Highlands bioregion. The mine development lies within the Orange subregion.

Approximately 726,530 ha (14.86%) of the South Eastern Highlands bioregion occupies conservation tenure, with national parks and nature reserves, including karst conservation reserves and 12 wilderness areas, comprising the majority (NSW National Parks & Wildlife Service, 2003). A number of flora reserves are managed under the *Forestry Act 1916*, occupying 0.1% of the bioregion, and contributing towards regional biodiversity. State forests are also managed for forestry products, occupying 7.31% of the bioregion (NSW National Parks & Wildlife Service, 2003). In an effort to increase regional biodiversity, landholders have entered into voluntary conservation agreements or hold wildlife refuges on their properties, as well as property agreements under the *Native Vegetation Conservation Act 1997* (NSW National Parks & Wildlife Service, 2003). However, in the vicinity of the mine development, agriculture and pastoralism is dominant.

2.2 Topography and geology

The South Eastern Highlands bioregion comprises dissected ranges and plateaus of the Great Dividing Range, substantial lower than the Australian Alps to the southwest. Basement rocks comprise Palaeozoic granites, metamorphosed sedimentary rocks and Tertiary basalts, with the highlands forming part of the Lachlan fold belt; a complex series of metamorphosed Ordovician to Devonian sandstones, shales and volcanic rocks (NSW National Parks and Wildlife Service, 2003). The oldest rocks are a small sliver of the Early Ordovician serpentinite, formed in marine conditions when an area of sea floor and an island arc closed up, and comprises sediment deposited from submarine landslides interbedded with quartz sandstone and basaltic tuffs. During the Tertiary period, volcanic activity was widespread, resulting in associated river sands and gravels in some areas, through to remnant vents, plugs, dykes, domes and lave fields in others (NSW National Parks and Wildlife Service, 2003). The mine development falls within the Silurian aged Anson Formation of the East Lachlan Fold Belt of New South Wales. The area is known for its dacite-rich volcaniclastic (NSW National Parks & Wildlife Service, 2003), with gold mineralisation hosted within a north-south striking east-dipping orebody. The orebody is thought to be approximately 1,000 m long by up to 260 metres wide, and to a depth in excess of 600 metres (NSW National Parks & Wildlife Service, 2003), although higher grade zones are located central within the deposit and form the target area of the McPhillamys Project gold resource (NSW National Parks & Wildlife Service, 2003).

In terms of topography, dominant features include plateau remnants, granite basins with prominent ridges, and the western ramp grading to the South Western Slopes. Various streams cut through the ridges, and valleys are narrow with little Quaternary sediment (NSW National Parks and Wildlife Service, 2003). Soils across the region vary in relation to altitude, temperature and rainfall, and the parent material of sedimentary or volcanic material. The mine development comprises an undulating landscape with elevations of between 872.43 m Australian height datum (AHD) and 1,017.82 m AHD, with open valleys and moderate to gentle slopes. North of Vittoria Road, there are a number of steeply incised valleys associated with the Ragans, Swallow and Oaky creeks, and a north-south ridge to the east forms the catchment divide between the Macquarie and Lachlan Catchments. Areas with slopes of less than 1:50 (V:H) are typically associated with the Belubula River floodplains and associated tributaries. The most significant topographic feature is Mt Canobolas (1,395 m), located approximately 35 km to the west-northwest of the mine development.

2.3 Hydrogeology

Regional groundwater flow is from north-east to south-west and locally is a subdued reflection of topography and coincides with surface drainage patterns. Groundwater in the vicinity of the mine development is dominated by the Palaeozoic metamorphic rocks originating from the Lachlan Fold Belt, with the Godolphin-Copperhania Fault Zone influencing groundwater flow locally (EMM Consulting Pty Ltd, 2019). Recharge occurs through percolation of rainfall and leakage from waterways, and discharge occurs via evapotranspiration, spring flow and contributions to surface waterways (EMM Consulting Pty Ltd, 2019). Delayed recharge may occur via rainfall storage within alluvial deposits along waterway banks and drainage, providing temporary groundwater storage. Three aquifer types occur in the vicinity of the mine development:

- shallow alluvial aquifers (associated with the Belubula River and tributaries);
- fractured rock aquifers (associated with the Anson Formation); and
- weathered rock aquifers (associated with permeable parts areas of saprock).

Quaternary-aged alluvium is present along the Belubula River and some tributaries, as well as within the mine development; however, is insufficient to support productive aquifers (EMM Consulting Pty Ltd, 2018). Similarly, the fractured rock aquifers are likely to be of low productivity due to marginal groundwater yields following exploratory drilling and based on publicly available data. The weathered rock aquifers are poorly developed; however, parts of the weathered zone are saturated and hold marginal aquifers (EMM Consulting Pty Ltd, 2018).

2.4 Catchment and drainage

The Lachlan catchment (Figure 1.2) covers an area of approximately 86,500 km^2 and is bounded by the Great Dividing Range, the Macquarie catchment, the Murrumbidgee catchment and the Darling catchment (EMM Consulting Pty Ltd, 2018). The primary drainage channel is the Lachlan River which terminates in the Great Cumbung Swamp wetlands, recognised as a nationally important wetland (Department of the Environment & Energy, 2010), more than 500 km west-southwest of the mine development. The Lachlan River, and therefore the Great Cumbung Swamp wetlands, rarely flow into the adjacent Murrumbidgee River. The proposed infrastructure is located in the upper Lachlan catchment, and in the headwater of the Belubula River where there are limited alluvial aquifers and rainfall runoff is intermittent and short-lived following rainfall events. The headwater of the Belubula River rises to the northeast of the mine development, within the adjacent Vittoria State Forest, and flows to the southwest towards Blayney, and then south-southwest into the Carcoar Dam. The Belubula River within the mine development generally exhibits no flow and no permanent pools, during dry conditions with the exception of some downstream sections.

Numerous tributaries flow into the Belubula River (Figure 1.2) which terminates in the constructed Carcoar Dam, approximately 26 km downstream. The Carcoar Dam has a catchment area of approximately 230 km^2 and a storage capacity of approximately 36 GL (WaterNSW, 2019), and is used for regulated releases for environmental, irrigation, stock and domestic purposes (R.W. Corkery & Co. Pty Ltd, 2018). The sub-catchment comprises highly modified agricultural land and a pine plantation, with substantial erosion resulting from clearing and agricultural land use. Drainage of agricultural land occurs via topographical depressions facilitating overland flow, and ephemeral streams, which cause inundation of the downstream sections of the Belubula River.

2.5 Ecology and habitats

No bioregionally-significant aquatic habitat or wetlands occur within the NSW portion of the South Eastern Highlands bioregion (NSW National Parks and Wildlife Service, 2003); however, a number of wetlands within the bioregion as a whole are listed as nationally important. These wetlands, and biodiversity in general, are currently under ecological pressure from exotic weeds, feral animals, grazing, sedimentation and altered water regimes, as well as recreational impacts (NSW National Parks and Wildlife Service, 2003). The local area surrounding the Belubula River is also highly fragmented, with native vegetation occurring only in isolated patches and surrounded by agricultural land. In addition, aquatic and riparian habitat is generally of poor condition, with invasive exotic species dominant and habitat modification prevalent (eg constructed dams, land clearing, surface flow barriers).

2.6 Climate

The Blayney-Orange district is characterised by a mild temperate climate with warm to hot summers and cool to cold winters. Rainfall is typically highest during the winter months. Rainfall data have been acquired from the McPhillamys Project weather station (monitored since 2013), and the surrounding Bureau of Meteorology (BoM) weather stations (Table 2.1). Records from the Scientific Information for Land Owners (SILO) have been obtained to augment the available rainfall data. SILO datasets are constructed from observational records provided by BoM. SILO processes the raw data, which may contain missing values, to derive datasets which are both spatially and temporally complete.

Table 2.1 Summary of rainfall records

Station	Name	Period	Elevation	Distance to mine development
Site[1]	McPhillamys	2013-present	~965 mAHD	Within the mine development area
63294	Blayney (Orange Rd)	1990-present	880 mAHD	8 km west south-west of mine development
63306	Bathurst (The Rocks)	1996-present	910 mAHD	11 km north-east of the mine development
63303	Orange Airport AWS	1996-present	945 mAHD	21 km north-west of the mine development
63254	Orange Agricultural Institute	1966-present	922 mAHD	28 km north-west of the mine development
SILO	Lat: -33.5. Long: 149.3	1900-present	993 mAHD	Covers the mine development

Notes: 1. The McPhillamys Project weather station is located at 714195 mE, 6291653 mN GDA94 Zone 55.

The long-term average annual rainfall for the area ranges from 710 mm (SILO) to 916 mm (Orange Agricultural Institute, BoM station 63254). The average annual rainfall total recorded at the site weather station between 2013 and 2018 is 670 mm. The annual pan evaporation for the area exceeds the rainfall total and averages 1,336 mm (SILO). The annual rainfall totals for each of the above rainfall records between 2000 to 2018 are presented in Figure 2.1. Over the past 18 years, 2010 was the wettest year and marked the end of the Millennium Drought (2002 to 2010). The next wettest year was 2016, with a rainfall total of 971 mm recorded at site and 1,345 mm recorded at the Orange Agricultural Institute. Mean climatic data (rainfall and evaporation) sourced from the climate stations in the area (refer Table 3.2) are presented in Figure 2.2. The figure shows that evaporation exceeds rainfall between January and April, and between September and December. Cumulative deviation from mean (CDFM) rainfall is the accumulated difference between rainfall (in a day, month or year) and the long-term mean, providing an indication of the general climatic trend over time as well as general water availability (soil water, surface water and groundwater). A CDFM plot of monthly rainfall SILO records from January 2000 to end of February 2019 is presented in Figure 2.3. The plot indicates climate (rainfall) variability is typical of the mine development, with periods of:

- above average rainfall occurring in the year 2000, between 2010 and 2012, and in 2016;
- below average rainfall occurring in 2002, from 2006 to 2010 and from 2017 to 2019; and
- around average rainfall occurring from 2003 to 2006, and from 2014 to 2016.

A comparison of rainfall accumulated from June 2013 to March 2019 for the site and SILO record is shown in Figure 2.4. The pattern of this accumulated rainfall and the small difference (3.3%) between the totals across the five years indicates that the SILO data provides a valid representation of the climate in the mine development.

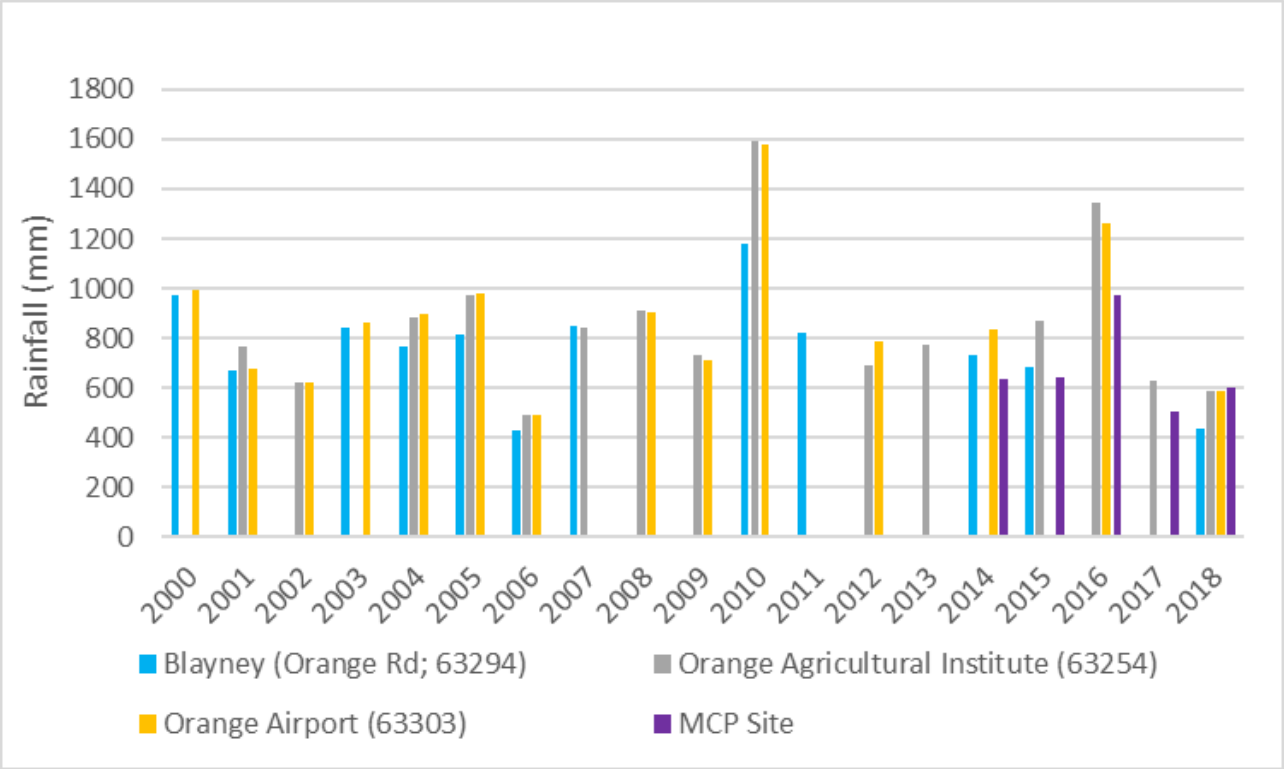


Figure 2.1 **Annual rainfall totals 2000 to 2018 (MCP site, BoM stations 63254, 63294 and 63303)**

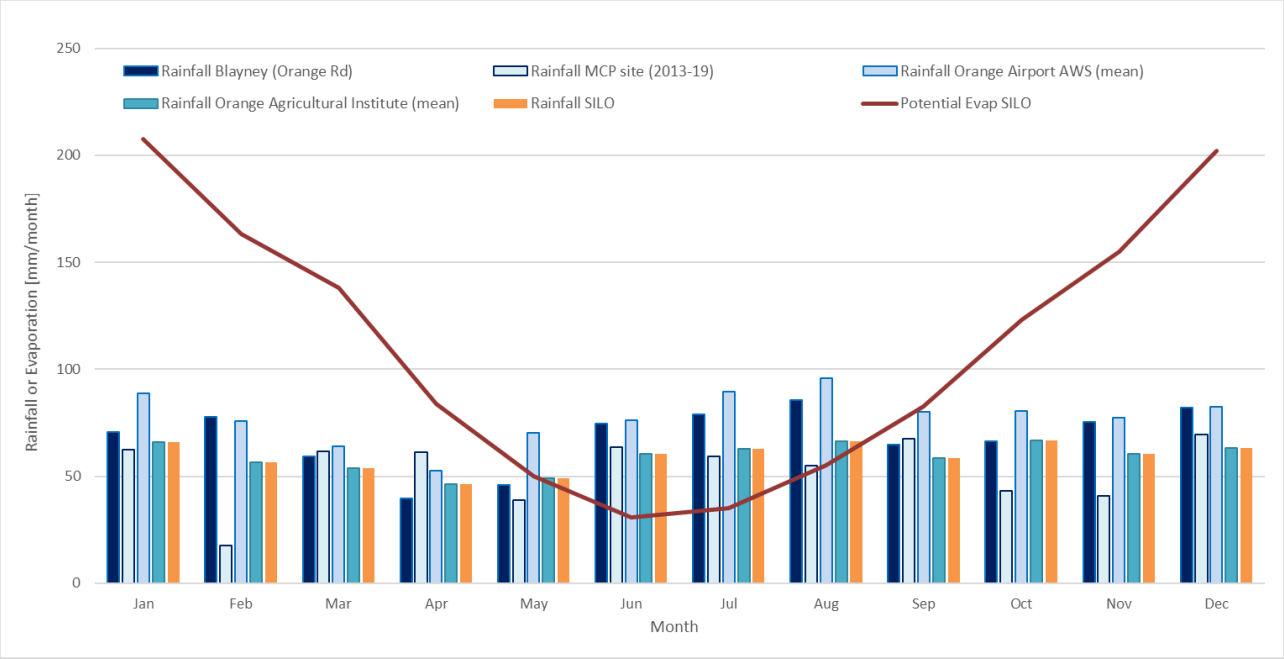


Figure 2.2 **Mean climatic conditions**

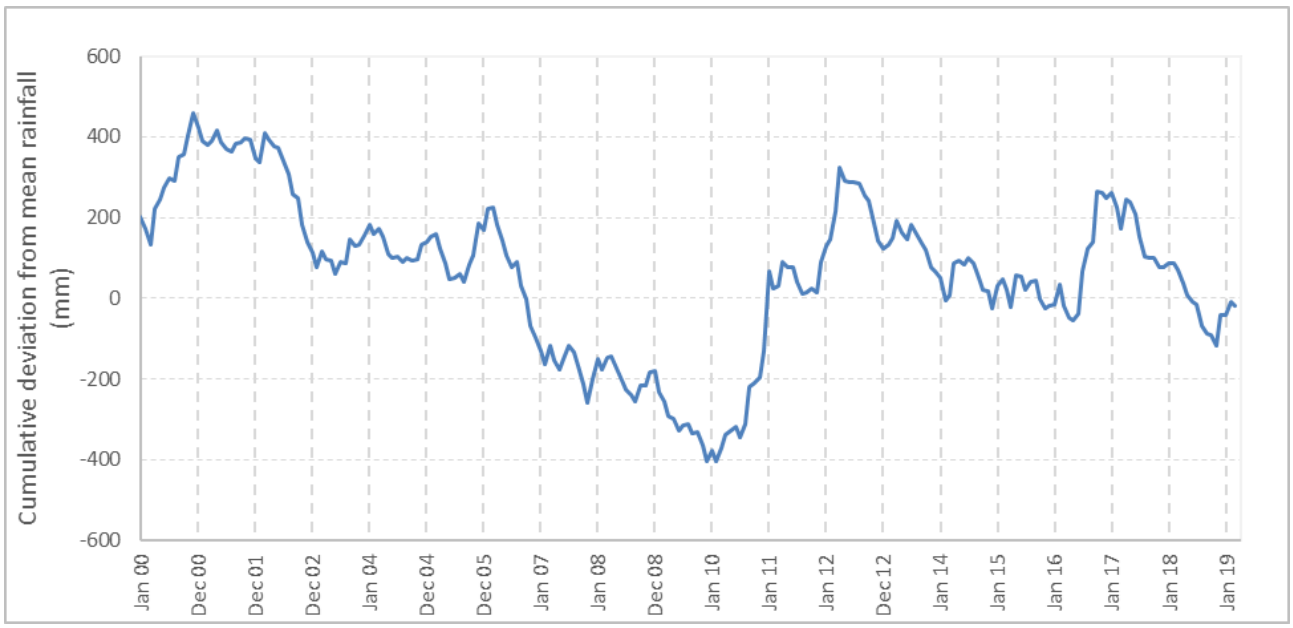


Figure 2.3 Cumulative deviation from mean monthly rainfall from SILO

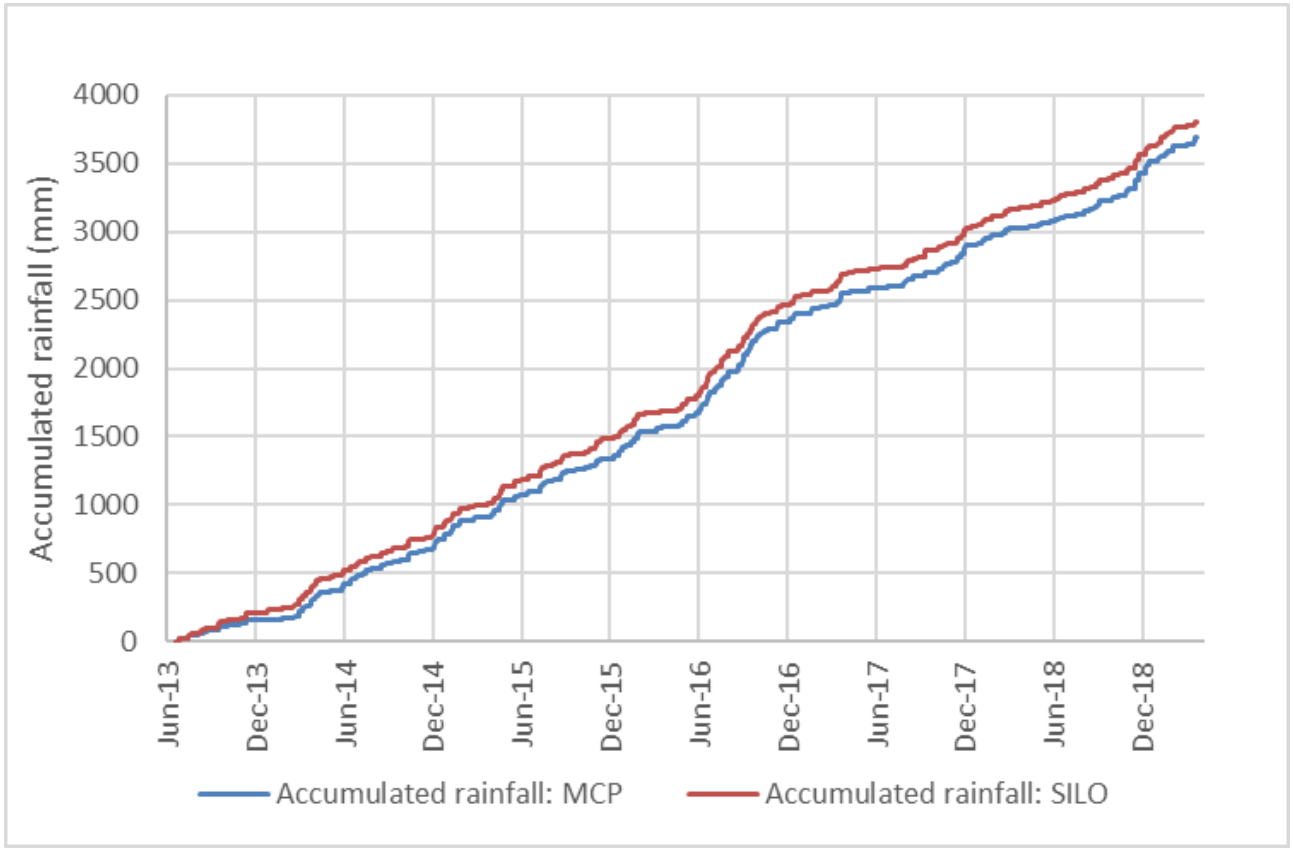


Figure 2.4 Rainfall accumulation comparison between SILO and McPhillamys project data records

3 Methods

3.1 Desktop review

3.1.1 Database searches and literature review

Database searches were undertaken to compile background information and to determine the likelihood of the occurrence of communities and taxa of conservation significance that may inhabit the Belubula River, its tributaries or the riparian zone, within or adjacent to the mine development. A total of nine databases were searched or consulted, comprising State and Commonwealth resources (Table 3.1).

Table 3.1 Summary of databases searched as part of the aquatic ecology assessment

Database	Authority	Coordinates	Search Area (radius)
Climate Data Online	Bureau of Meteorology	n/a	n/a
Threatened species lists	DPI Fisheries	n/a	n/a
Freshwater Threatened Species Distribution Maps	DPI Fisheries	n/a	n/a
Threatened Biodiversity Profile Search	Office of Environment & Heritage (OEH)	n/a	n/a
BioNet	OEH	55 H 715595 6293828^	20 km
Australian Ramsar Wetlands: Internationally important wetlands	Department of the Environment & Energy (DEE)	n/a	South Eastern Highlands bioregion
Directory of Important Wetlands: Nationally Important Wetlands	DEE	n/a	South Eastern Highlands bioregion
Protected Matters Search Tool	DEE	55 H 715595 6293828^	20 km
New South Wales Flora Online	PlantNET	n/a	n/a

Note: ^ indicates coordinate central to the mine development.

A literature search of publicly available information relating to the aquatic and riparian environment, within and adjacent to the mine development, was completed to investigate the occurrence of communities and taxa of conservation significance. Information was compiled from reports, books, journals, and relevant government, university or regulatory publications. Primary data sources for the literature comprised reports by EMM Consulting Pty Ltd (2018; 2018; 2019; 2019) and EnviroKey Pty Ltd (2014; 2017).

3.1.2 Stream order

The method for assigning stream order is known as the Strahler (1952) system. The Strahler (1952) system assigns waterways an 'order' according to the number of additional tributaries associated with each waterway, with this stream order then referred to as the 'mapped stream order'. Prior to undertaking the aquatic ecology assessment, EMM was commissioned to validate local catchment stream order within the mine development, based on scientific, geomorphic principals and aerial photography. Specific methods can be found in EMM Consulting Pty Ltd (2018). However, the stream orders referred to within the aquatic ecology assessment have been taken from GIS data received from the DPI (2013) in 2015.

3.1.3 Water quality

With regard to water quality, several assessments have been undertaken by EnviroKey Pty Ltd (2014) and EMM Consulting Pty Ltd (2018), with methodology documented in each report. A brief summary of these results are presented to provided context for the aquatic ecology assessment, with comparison of water quality made to ANZECC & ARMCANZ (2000)[1], Foged (1978) and Hammer (1986).

[1] For the protection of 80% of species in highly disturbed freshwater aquatic ecosystems

3.2 Survey design

The aquatic ecology assessment comprised a single field survey undertaken over three days (20th-22nd November 2018) during predominantly dry conditions. However, during the third field day, 52 mm of rain was recorded (Section 2.6), resulting in high flows observed in Trib A but no discernible difference in flow within the Belubula River. A total of 15 sites, within the Belubula River, three associated tributaries, and their riparian zones, were assessed for key fish habitat and riparian vegetation condition (Table 3.2), respectively, throughout the Belubula River and associated tributaries (Figure 3.1). At each site, a waterway type and class assessment was completed, which involved defining a range of ecological components including habitat, vegetation and substrate types, waterway morphology, presence/absence/flow of surface water, refuge availability, amount of erosion, bank incision, and livestock impact. Each waterway assessed had previously been ranked according to the Strahler (1952) method of stream ordering (Department of Primary Industries, 2013). A brief riparian condition assessment was included, which documented vegetation and debris cover, the presence of native species and habitat type. A broad habitat characterisation was undertaken at each site to document other attributes of the local ecosystem including presence of weeds. Photographs were taken at all sites to provide a record of habitat conditions at the time of assessment (Appendix A). It should be noted that no in-field survey was able to be undertaken within Trib F due to the presence of a large dam structure, and an assessment was not undertaken with the unnamed tributary (referred to as Trib G herein) as there was no detectable waterway and surface water features were limited to constructed pastoral dams.

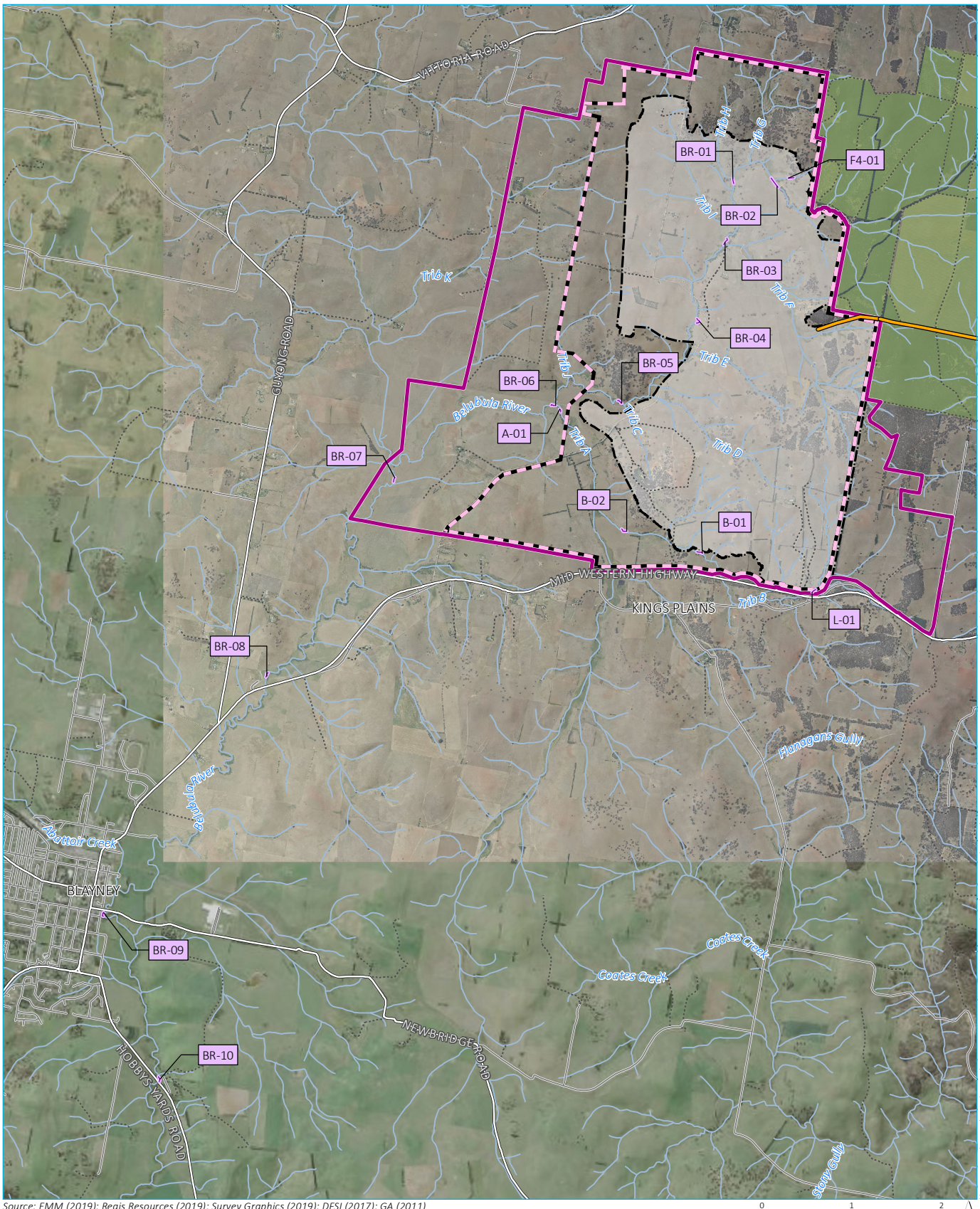
Table 3.2 Location of sites surveyed during the aquatic ecology assessment

Date	Waterway	Stream Order	Site	Coordinates
20-Nov-18	Belubula River	4th	BR-01	55 H 716587 6295550
20-Nov-18	Belubula River	3rd	BR-02	55 H 717015 6295560
20-Nov-18	Belubula River	4th	BR-03	55 H 716525 6294882
20-Nov-18	Trib F4	2nd	F4-01	55 H 717267 6295558
21-Nov-18	Trib A	5th	A-01	55 H 714659 6292979
21-Nov-18	Trib A	3rd	B-01	55 H 716184 6291390
21-Nov-18	Trib A	4th	B-02	55 H 715348 6291641
21-Nov-18	Belubula River	5th	BR-04	55 H 716188 6293992
21-Nov-18	Belubula River	5th	BR-05	55 H 715348 6293040
22-Nov-18	Belubula River	6th	BR-06	55 H 714561 6293020
22-Nov-18	Belubula River	6th	BR-07	55 H 712818 6292215
22-Nov-18	Belubula River	6th	BR-08	55 H 711407 6290035
22-Nov-18	Belubula River	6th	BR-09	55 H 709574 6287364
22-Nov-18	Belubula River	6th	BR-10	55 H 710185 6285535
22-Nov-18	Trib L	3rd	L-01	55 H 717515 6290966

Note: Blue shading indicates sites located within waterways noted in the DPI Fisheries Agency requirements as requiring assessment of key fish habitat, excluding Trib F and Trib G which were not assessed.

3.2.1 Survey team

The field survey was undertaken by two suitably qualified EMM scientists; Nathan Garvey, an Associate Ecologist with over 15 years' experience in undertaking ecological investigations, and Janet Krick, a Senior Environmental Scientist with more than 10 years' experience.



Source: EMM (2019); Regis Resources (2019); Survey Graphics (2019); DFSI (2017); GA (2011)

0 1 2 km

GDA 1994 MGA Zone 55

N

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KEY

Key fish habitat sample site

Project application area

Mine development project area (2,513.47 ha)

Mining lease application area (1,812.99 ha) (Note: boundary offset for clarity)

Pipeline corridor

Disturbance footprint

Existing environment

Main road

Local road

Vehicular track

Watercourse/drainage line

Vittoria State Forest

Survey sites located within, and adjacent to, the mine development

McPhillamys Gold Project
Aquatic ecology assessment
Figure 3.1

REGIS RESOURCES LTD

EMM creating opportunities

3.2.2 Key fish habitat

In accordance with *Policy and guidelines for fish habitat conservation and management* (Department of Primary Industries, 2013), habitat sensitivity was assessed at each survey site by assigning a 'waterway type', while the functionality of the waterway as fish passage was assessed by assigning a 'waterway class'. 'Sensitivity' is defined by '*…the importance of the habitat to the survival of fish and its robustness (ability to withstand disturbance)*' (Department of Primary Industries, 2013). Definitions, relevant to the aquatic ecology assessment, of the waterway types and waterway classes are summarised in Table 3.3 and Table 3.4, respectively, and are provided in full in Appendix B (Department of Primary Industries, 2013). It should be noted that DPI Fisheries (2013) requires aquatic plants to be native with regard to waterway type classification. Where it was not known as to whether a plant was native or exotic, a conservative approach was taken, potentially overestimating waterway type.

Table 3.3 Waterway type definitions for habitat sensitivity

Classification	Characteristics of waterway class
Type 1 – Highly sensitive key fish habitat	Freshwater habitats that contain in-stream gravel beds, rocks greater than 500 mm in two dimensions, snags greater than 300 mm in diameter or 3 metres in length, or native aquatic plants.
Type 2 – Moderately sensitive key fish habitat	Freshwater habitats and brackish wetlands, lakes and lagoons other than those defined in Type 1.
Type 3 – Minimally sensitive key fish habitat	Ephemeral aquatic habitat not supporting native aquatic or wetland vegetation.

Table 3.4 Waterway class definitions for fish passage

Classification	Characteristics of waterway class
Class 1 – Major key fish habitat	Marine or estuarine waterway or permanently flowing or flooded freshwater waterway (eg river or major creek), habitat of a threatened or protected fish species or 'critical habitat'.
Class 2 – Moderate key fish habitat	Generally named intermittently flowing stream, creek or waterway with clearly defined bed and banks, semi-permanent to permanent water in pools or in connected wetland areas. Freshwater aquatic vegetation is present. Type 1 and Type 2 habitats present.
Class 3 – Minimal key fish habitat	Named or unnamed waterway with intermittent flow and sporadic refuge, breeding or feeding areas for aquatic fauna (eg fish, yabbies). Semi-permanent pools form within the waterway or adjacent wetlands after a rain event. Otherwise, any minor waterway that interconnects with wetlands or other Class 1-3 fish habitats.
Class 4 – Unlikely key fish habitat	Generally unnamed waterway with intermittent flow following rain events only, little or no defined drainage channel, little or no flow or free-standing water or pools post-rain events (eg dry gullies, shallow floodplain depressions with no aquatic flora).

Following the application of DPI Fisheries (2013) methods, notes were made on the following components, with regard to habitat features:

- presence of native versus exotic bank vegetation;
- presence, length and depth of semi-permanent or permanent pools; and
- surface water turbidity.

3.2.3 Riparian vegetation

In addition to the key fish habitat assessment outline above, at each survey site, notes were made on the following components, with regard to riparian zone condition:

- habitat continuity and extent;
- vegetation cover and structural complexity;
- dominance of natives versus exotics; and
- standing dead trees, hollows, fallen logs and leaf litter.

4 Results and discussion

4.1 Desktop review

4.1.1 Ecology and habitats

A number of significant ecosystems and nationally important wetlands are located with the South Eastern Highlands Bioregion, and NSW more broadly; however, these systems are located between 300 km and 800 km from the mine development (Department of the Environment and Energy, 2018). With regard to significant aquatic systems, the nearest Ramsar wetlands occur more than 170 km to the east-southeast (Towra Point Nature Reserve), 230 km to the south-southwest (Ginini Flats Wetland Complex), and 300 km to the north-northwest (Macquarie Marshes) (Department of the Environment and Energy, 2018).

Results of the database searches and literature review indicated that one endangered ecological community (EEC) is associated with the Belubula River; the FM Act-listed Lachlan River EEC, which commences downstream of Carcoar Dam (approximately 20 km southwest of the mine development), and includes the Great Cumbung Swamp, located more than 500 km west-southwest of the mine development (Department of Primary Industries, 2006). This EEC protects vertebrate and invertebrate fauna within all waterways associated with the lowland catchment of the Lachlan River.

Further upstream, Carcoar Dam is currently documented as supporting, predominantly through restocking programs, exotic species including Brown Trout (**Salmo trutta*), Rainbow Trout (**Oncorhynchus mykiss*) and Redfin Perch (**Perca fluviatilis*; Class 1 noxious fish (Department of Primary Industries, 2019))[2], as well as the native Golden Perch (*Macquaria ambigua*) (Department of Primary Industries, 2019). In addition, the Silver Perch (*Bidyanus bidyanus;* listed under the FM Act as Vulnerable) and the Murray Cod (*Maccullochella peelii*; listed under the EPBC Act as Vulnerable) are also stocked as part of conservation initiatives (Department of Primary Industries, 2019). In terms of the riparian environment, there are no communities specifically listed under any State or Commonwealth legislation.

The upper reaches of the Belubula River, above the confluence with Trib A and within the mine development, are ephemeral and consist of isolated pools, while downstream of Trib A the Belubula River appears to be perennial (EMM Consulting Pty Ltd, 2019). During an August 2018 assessment, undertaken by EMM Consulting Pty Ltd (2018), flowing water was recorded from three sites located in the north, central and south-west of the mine development, while EnviroKey Pty Ltd (2014) previously observed multiple in-stream features including trailing bank vegetation, large woody debris (snags and logs), coarse particulate organic material, macrophyte beds and filamentous algae. However, increasing bank erosion and incision was noted between assessments, attributed primarily to an increase in livestock access, with grazing noted as a contributing factor to deterioration in aquatic and riparian habitat condition over time (EMM Consulting Pty Ltd, 2018) (EnviroKey Pty Ltd, 2014). It is also unlikely that this area will hold surface water for any prolonged period, reducing the likelihood that the majority of waterways would provide suitable habitat to support migration and breeding among local populations of resident native aquatic fauna. However, the potential also exists for the lack of surface water to be attributed, in part, to historic below-average rainfall.

In addition, a lack of connectivity between sites exists in this area during baseflow ('low-flow') conditions, attributed to the degree of landscape modification currently experienced by the broader upstream area of the Belubula River. Areas where fish passage is already artificially impeded include:

- the Dungeon Road causeway;
- two locations downstream and upstream of BR-06; and
- a dam upstream of BR-07.

These areas were not directly assessed during the initial field program; however, Regis provided the information and images, following some reconnaissance field assessment. The location of the Dungeon Road causeway has resulted in a 300 mm head loss where the erosion of an existing culvert, and concrete footing, on the downstream side of the road crossing is currently blocking surface water flow and therefore fish passage (Plate 4.1). At an additional site, downstream of BR 06, the presence of a large Willow tree and its root system, has caused extensive

[2] Previously-existing and not part of a restocking program.

build-up of organic matter, resulting in accumulation of surface water and therefore impeding fish passage (Plate 4.2). A third site upstream of BR 05 shows similar blockages and sedimentation caused by a Willow (Plate 4.3). Upstream of BR-07, a waterway crossing and livestock watering point have been constructed which in combination with a previously existing dam, has caused substantial erosion to the waterway bed and banks. The accumulation of surface water at this point also indicates that fish passage is impeded (Plate 4.4).

EMM Consulting Pty Ltd (2018) also indicated, in terms of riparian vegetation that the increase in livestock-associated erosion and grazing was also responsible for the deterioration in vegetation communities, in conjunction with a lack of linear continuity, structural diversity and the impacts of introduced vegetation (EMM Consulting Pty Ltd, 2018). Similar results were also documented by EnviroKey Pty Ltd (2014), who noted that the majority of native vegetation has been cleared to the top of the bank, allowing for infilling by exotic pasture grasses and hawthorn bush, blackberry and roses. Rapid assessment of riparian vegetation returned scores ranging between 8.5 and 26.25 out of a maximum of 50 (EnviroKey Pty Ltd, 2014). which was consistent with previous findings. However, this is likely to be reflective of the broader catchment and not confined to waterways within, and adjacent to, the mine development. It should be noted that a previously-recorded general decrease in canopy, understorey and ground vegetation cover could also be attributed, in part, to the below-average rainfall recorded over the last five out of six years (Hydro Engineering & Consulting Pty Ltd, 2019).

Plate 4.1 **Evidence of existing impediment to fish passage (Dungeon Road causeway) upstream of BR-04, Belubula River**

Plate 4.2 **Evidence of existing impediment to fish passage (55H 713711 6293041) downstream of BR-06, Belubula River**

Plate 4.3 **Evidence of existing impediment to fish passage (55H 715940 6293524) upstream of BR-05, Belubula River**

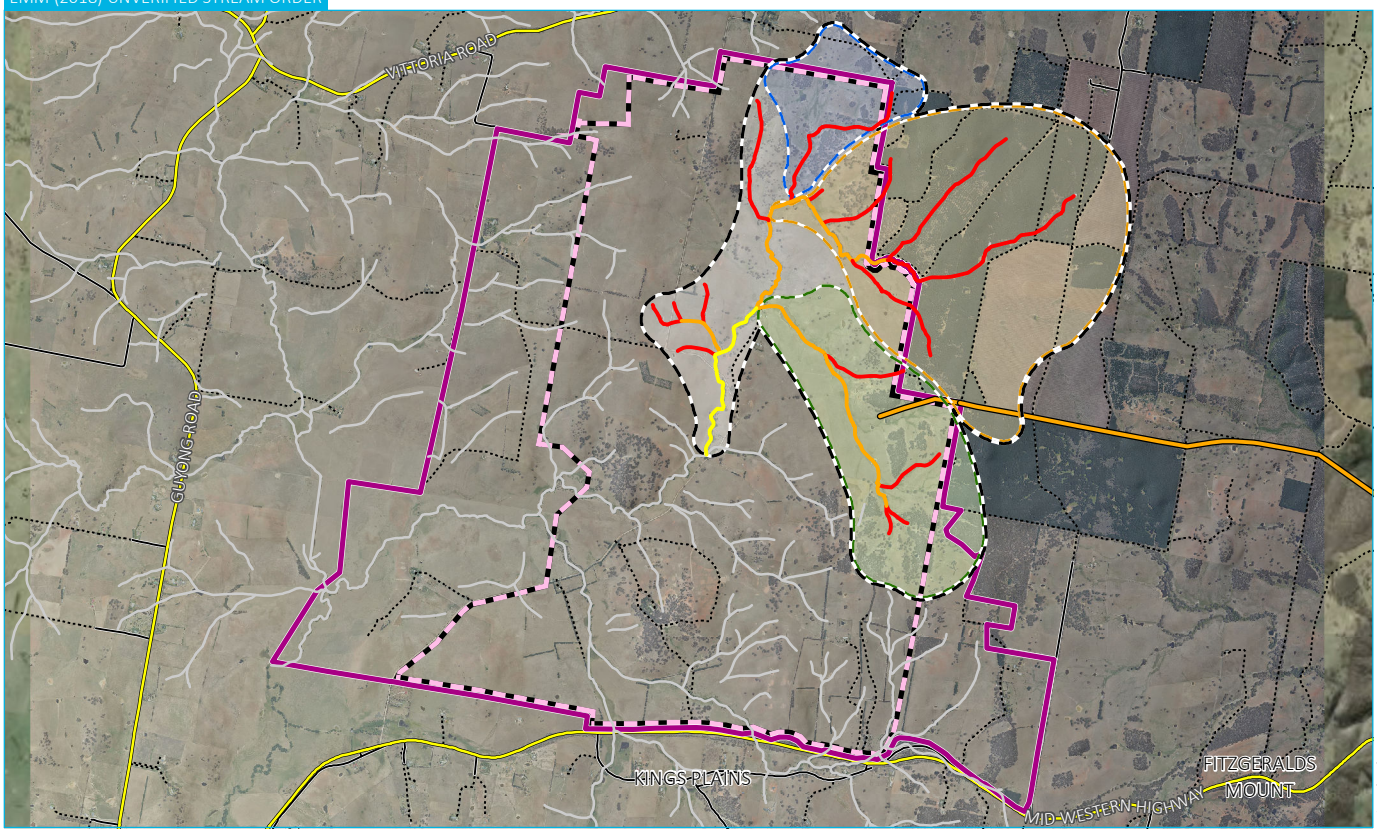
Plate 4.4 **Evidence of existing impediment to fish passage (55H 713524 6292895) upstream of BR-07, Belubula River**

4.1.2 Stream order

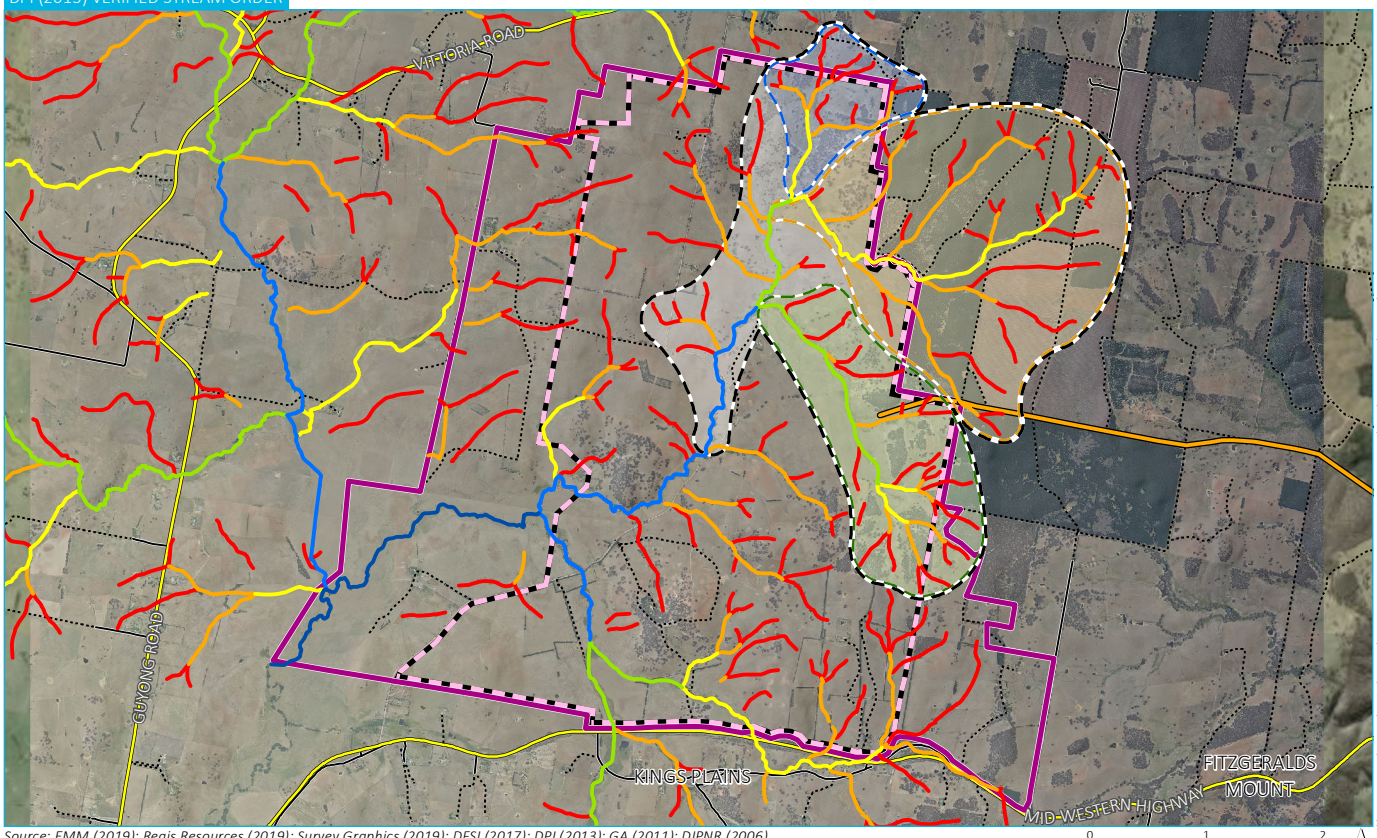
The stream order assessment undertaken by EMM Consulting Pty Ltd (2018) aimed to validate stream order in the upper reaches of the surface water catchment, within the vicinity of the mine development but excluding the wider Belubula River catchment. The assessment demonstrated that a high number of mapped tributaries do not meet the definition of a minor stream, particularly within the headwater of the catchment and within the state forest. This is attributed to highly modified landscapes associated with clearing for agriculture and grazing, as well as forestry applications. As a result, only two identifiable flow pathways were able to be mapped, with the remainder generally represented by topographic depressions which may contain surface water flows during high rainfall events (EMM Consulting Pty Ltd, 2018). This is particularly relevant to the aquatic ecology assessment as a lack of defined banks, incised channels and fringing vegetation results in degraded habitat, habitat complexity and water quality.

In addition, a lack of connectivity between sites is also typical of this area during low-flow conditions, attributed to the degree of landscape modification currently experienced by the broader upstream area of the Belubula River. It is acknowledged that the catchment for Trib A (24.4 km^2) is larger than that of the Belubula River (~17.5 km^2) (Hydro Engineering & Consulting Pty Ltd, 2019), upstream of Trib A, so flow is generally maintained, albeit impacted by farm dams and other infrastructure. The results presented by EMM Consulting Pty Ltd (2018) indicated that current stream order has the potential to be incorrect, and presents an overestimation of the number of streams in the mine development as representing a certain order. However, the aquatic ecology assessment has referred to classification approved by the DPI (2013), depicted in the '*DPI (2013) unverified stream order*' figure (Figure 4.1). Specific methods for the EMM assessment can be found in EMM Consulting Pty Ltd (2018), and the resultant stream order is depicted in the '*EMM Consulting Pty Ltd* (2018) *unverified stream order*' figure (Figure 4.1).

EMM (2018) UNVERIFIED STREAM ORDER



DPI (2013) VERIFIED STREAM ORDER



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Source: EMM (2019); Regis Resources (2019); Survey Graphics (2019); DFSI (2017); DPI (2013); GA (2011); DIPNR (2006)

0 1 2 km

GDA 1994 MGA Zone 55

N

KEY

Project application area
- Mine development project area (2,513.47 ha)
- Mining lease application area (1,812.99 ha) (Note: boundary offset for clarity)
- Pipeline corridor

Existing environment
- Main road
- Local road
- Vehicular track

- Target area
- North catchment
- East catchment
- South-east catchment

Stream order
- Not assessed
- 1st order
- 2nd order
- 3rd order
- 4th order
- 5th order
- 6th order

Stream order assessment rankings within, and adjacent to, the mine development

McPhillamys Gold Project
Aquatic ecology assessment
Figure 4.1

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4.1.3 Water quality

Water quality within the mine development has been monitored by Regis since May 2014 at 21 locations (Hydro Engineering & Consulting Pty Ltd, 2019). Samples were originally collected on a monthly basis for the first 10 months then quarterly until February 2017 at which time monthly sampling recommenced. Some monitoring sites comprise springs and therefore the water quality characteristics of these sites may be more representative of groundwater rather than surface water.

Data was compared with default guideline trigger values (ANZECC & ARMCANZ, 2000), also termed Water Quality Objectives (WQOs) in NSW, for the protection of aquatic ecosystems (at 80% level of species protection) in south-eastern Australian upland rivers. The 80% level of species protection was selected due to the disturbed nature of the surface water systems within and downstream of the project area. Exceeded of the WQOs were recorded (Hydro Engineering & Consulting Pty Ltd, 2019), and are likely attributed to natural catchment conditions and/or land use modification.

Surface water quality within the vicinity of the mine development ranges from slightly acidic to alkaline. The pH values were on occasions both above and below the WQO range with 14 of 21 sites recording exceedances. Recorded salinity ranged from fresh to hyposaline with the EC WQO exceeded at all sites excepting two. There were no exceedances of the WQO for sulphate, arsenic, cadmium or cyanide recorded at any location. The WQO for zinc was exceeded in some samples collected at four sites (Hydro Engineering & Consulting Pty Ltd, 2019). The total nitrogen and total phosphorus WQOs were exceeded in the majority of samples from all sites in which total nitrogen and total phosphorus were recorded. These baseline results suggest that the default guideline trigger values (ANZECC & ARMCANZ, 2000) are not representative of the background conditions in the mine development and site specific WQOs should be developed (Hydro Engineering & Consulting Pty Ltd, 2019).

4.1.4 Fauna

While more than 150 species of birds, frogs, reptiles and mammals have been recorded in the local area (Appendix C), the fish fauna of are particular importance to the aquatic ecology assessment (Table 4.1), due to their reliance on waterways compared to other more mobile groups like migratory birds. A total of five fish species were identified in the database searches as having the potential to occur within, or adjacent to, the mine development and were listed as either Vulnerable or Endangered under the FM Act or EPBC Act (Table 4.1):

- Southern Purple-spotted Gudgeon (family Eleotridae);
- Trout Cod (*Maccullochella macquariensis*; family Percichthyidae);
- Murray Cod (*Maccullochella peelii*; family Percichthyidae);
- Macquarie Perch (*Macquaria australasica*; family Percichthyidae); and
- the Eel-tailed Catfish (family Plotosidae; Murray-Darling Basin population).

Table 4.1 Summary of database search results relevant to aquatic taxa of conservation significance

Family	Taxa	Vernacular	Conservation Significance	FM Act / EPBC Act Likelihood Of Occurrence
Eleotridae	*Mogurnda adspersa*	Southern Purple-spotted Gudgeon	Endangered^	Possible
Percichthyidae	*Maccullochella macquariensis*	Trout Cod	Endangered^	Possible
Percichthyidae	*Maccullochella peelii*	Murray Cod	Vulnerable+	Possible
Percichthyidae	*Macquaria australasica*	Macquarie Perch	Endangered^	Possible
Plotosidae	*Tandanus tandanus*+	Eel-tailed Catfish	Endangered^	Possible

Note: + indicates Murray-Darling Basin population; + indicates listing under the EPBC Act; ^ indicates listing under the FM Act.

The database searches and literature review indicates that it is considered possible that these species could occur within local waterways due to their historic occurrence within the Lachlan, Murrumbidgee, Macquarie, Darling and Murray rivers of the Murray-Darling Basin, as well as associated tributaries (Department of Primary Industries, 2018) (Department of Primary Industries, 2018) (Department of the Environment and Energy, 2018). However, the larger pelagic species (Trout Cod, Murray Cod, Macquarie Perch) are unlikely to occur within waterways of the magnitude due to the level of disturbance and a lack of connectively in the vicinity of the mine development. In addition, DPI Fisheries-provided threatened species distribution mapping shows that the Eel-tailed Catfish and the Southern Purple-spotted Gudgeon are currently largely absent from the waterways immediately adjacent to the mine development (Figure 4.2) (Department of Primary Industries, 2019). It should also be noted that while Commonwealth and State data sources indicate 'possible' presence of these species, local conditions should be considered when determining actual likelihood of occurrence.

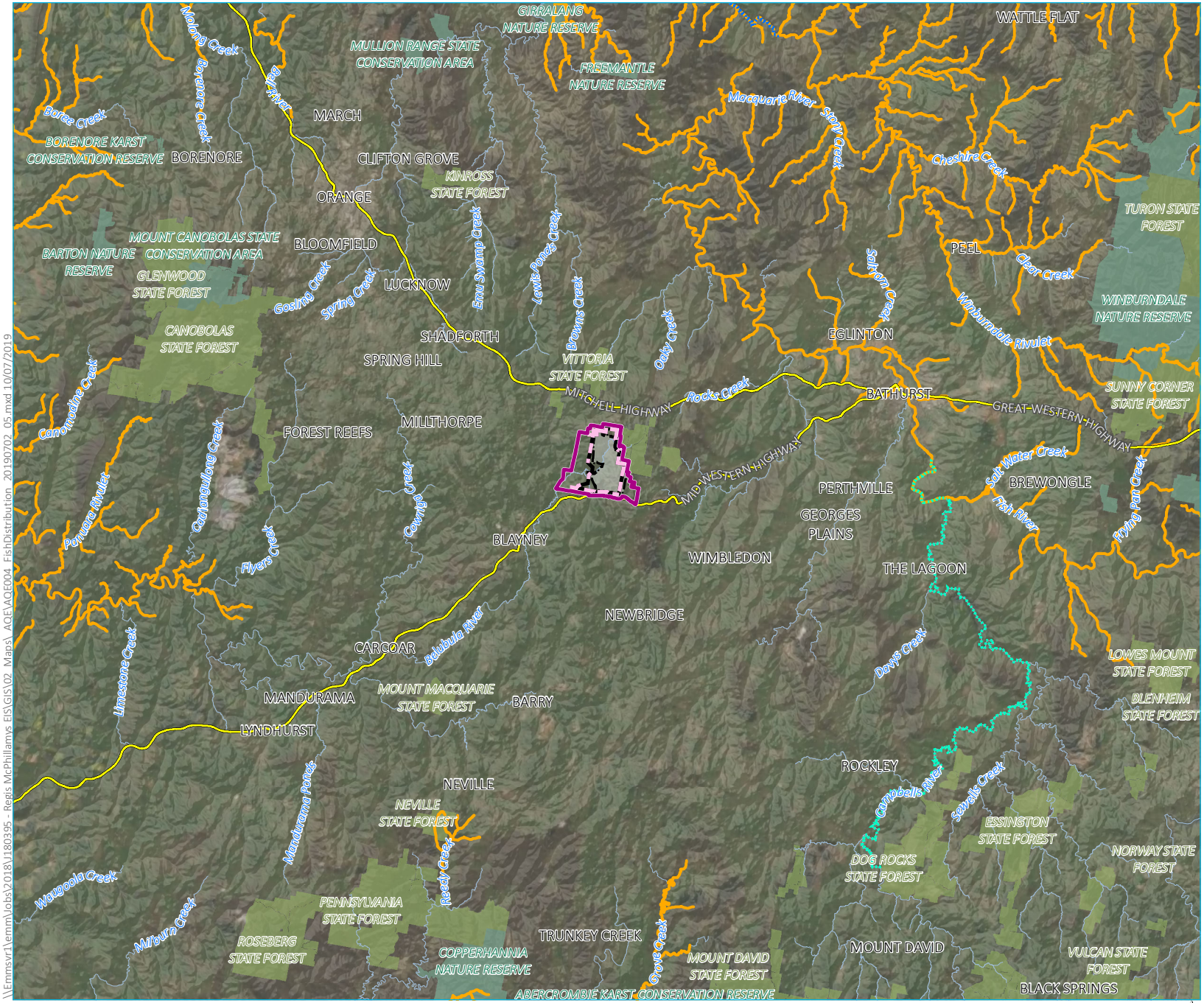
The Eel-tailed Catfish is a benthic feeder, allowing it to forage in shallower water on aquatic insect larvae, small fish and molluscs (Fish Base, 2019). Recent population decline is attributed to competition for resources with exotic species, habitat degradation and fishing pressure. It is considered that the species is now largely absent from the Murray, Murrumbidgee and Lachlan catchments (Department of Primary Industries, 2018), as supported by publicly-available spatial datasets (Figure 4.2) (Department of Primary Industries, 2019). It is considered that the Eel-tailed Catfish unlikely to occur within the mine development, as the species is more suited to slower moving waterways with fringing vegetation, including lakes and ponds, more similar to downstream areas of the Belubula River.

Similarly to the Eel-tailed Catfish, the Southern Purple-spotted Gudgeon prefers slow-flowing or still waters with a substantial amount of macrophyte coverage or a rocky benthos (Fish Base, 2019), and is a benthopelagic feeder on larvae and small fish. While breeding in the Eel-tailed Catfish occurs irrespective of water temperature, the Southern Purple-spotted Gudgeon requires a specific temperature range (19°C-34°C) in which spawning occurs. This species requires solid demersal substrates near vegetation on which to lay their eggs, differing from the Eel-tailed Catfish which build a nest within macrophytes. Causes of population decline are similar to that of the Eel-tailed Catfish, with the Southern Purple-spotted Gudgeon also subject to predation by Redfin Perch and competition from mosquitofish (**Gambusia holbrooki*) (Department of Primary Industries, 2018). While this species was historically widespread in the Murray, Murrumbidgee, Darling and Lachlan river systems, it is now considered extremely rare in inland NSW, and has only been recorded once since 1983 (Department of Primary Industries, 2018), also supported by publicly-available spatial datasets (Figure 4.2) (Department of Primary Industries, 2019).

4.1.5 Flora and vegetation

To date, more than 100 flora taxa have been recorded within the local area, comprising a similar number of native (62) and exotic (42) species, with no threatened flora species identified (EnviroKey Pty Ltd, 2017). A total of four plant community types (PCTs) have been identified; however, they have not been considered further due to the cleared nature of the riparian zone, as well as the dominance of exotic plant species. A number of aquatic plants have also been recorded from the Belubula River and associated tributaries, with only three species of exotic macrophyte identified; Jointed Rush (*Juncus articulates*), Celery Leaved Buttercup (*Ranunculus sceleratus* subsp. *sceleratus*) and Common Dock (*Rumex crispus*) (EnviroKey Pty Ltd, 2017). Overall, sites downstream within the Belubula River tended to have higher diversity of macrophytes than upstream sites.

In terms of local flora, the database searches indicate that up to 11 species of conservation significance have the potential to occur within, and adjacent to, the mine development (Appendix C). These plants include representatives from the Asteraceae, Brassicaceae, Fabaceae, Myrtaceae, Orobanchaceae, Poaceae, Rutaceae and Santalaceae families, with the majority of these taxa unlikely to occur within the mine development or within the riparian zone of a waterway. The exceptions include Black Gum (*Eucalyptus aggregata*; family Myrtaceae), *Philotheca ericifolia* (family Rutaceae) and Austral Toadflax (*Thesium australe*; family Santalaceae) (Table 4.1). While Black Gum and Austral Toadflax are listed as 'species or species habitat likely to occur within the area' under the EPBC Act, *Philotheca ericifolia* 'may occur within the area' (Department of the Environment and Energy, 2018). However, existing ecological assessments indicate that it is unlikely that *Philotheca ericifolia* and Austral Toadflax would a occur within, or adjacent to, the mine development (EnviroKey Pty Ltd, 2017; EMM Consulting Pty Ltd, 2019). Furthermore, while Black Gum prefers the lowest areas of the landscape, occurring on alluvial soils, cold, poorly-drained flats and hollows adjacent to creeks and small rivers, targeted searches did not identify this species within the mine development (EnviroKey Pty Ltd, 2017; EMM Consulting Pty Ltd, 2019).



KEY

Project application area

- Mine development project area (2,513.47 ha)
- Mining lease application area (1,812.99 ha) (Note: boundary offset for clarity)
- Disturbance footprint

Existing environment

- Primary road
- Perennial watercourse
- NPWS reserve
- State forest

Fish distribution

- Eel tailed Catfish
- Macquarie Perch
- Purple Spotted Gudgeon

Source: EMM (2019); Regis Resources (2019); DFSI (2017); GA (2011)

0 10 20 km

GDA 1994 NSW Lambert

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Potential distribution of the Eel-tailed Catfish, Purple-spotted Gudgeon and Macquarie Perch adjacent to the mine development

McPhillamys Gold Project
Aquatic ecology assessment
Figure 4.2

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4.2 Field survey

4.2.1 Key fish habitat

Results from the key fish habitat waterway assessments undertaken at 15 sites during the November 2018 field survey are summarised below (Table 4.2, Table 4.3):

- 10 waterways, ranging from 3rd to 6th order, were classified as Type 1-highly sensitive key fish habitat;
- Four 6th order streams, were classified as Type 2-moderately sensitive key fish habitat; and
- One 2nd order stream was classified as Type 3-minimally sensitive key fish habitat[3].

Of the 10 Type 1-highly sensitive key fish habitat waterways, four sites from the Belubula River (4th to 6th order) and one site from Trib A (5th order) were classified as Class 2-moderate key fish habitat (BR-03, BR-04, BR-05, BR-08; A-01) (Table 4.2). A further four sites, two from the Belubula River (3rd order, 4th order) and two from Trib A (3rd order, 4th order), were classified as Class 3-minimal key fish habitat (BR-01, BR-02; B-01, B-02) (Table 4.2). One site within Trib L was classified as Class 4-unlikely key fish habitat (L-01). It is considered unlikely that sites A-01, B-01, B-02, BR-01, BR-02, BR-04, BR-05 and BR-08 would support the species of conservation significance identified within the desktop review (Table 4.1). it is considered highly unlikely that site L-01 would support the species of conservation significance identified within the desktop review (Table 4.1).

Within the four Type 2 waterways, four sites within the Belubula River (6th order) were classified as Class 2-moderate key fish habitat (BR-06, BR-07, BR-09, BR-10) (Table 4.2). One site within Trib F4 was classified as Type 3-minimally sensitive key fish habitat and Class 4-unlikely key fish habitat (Table 4.2). While the potential exists for water quality, aquatic vegetation, and in-channel debris and vegetation to provide appropriate key fish habitat, it was still considered unlikely that sites would support threatened species due to a number of factors observed in the field, comprising:

- dams that would likely impede surface flow and therefore fish passage;
- degraded riparian zones, and erosion of channel banks and substrate;
- an abundance of weeds and other exotic vegetation on the fringe of the channels;
- sediment alluviation and silty substrates which may increase turbidity and sedimentation during flow events;
- impacts from livestock and grazing; and
- proximity of the majority of the waterways to agricultural zones, with a number of sites potentially affected by major roads, rubbish and residential inflows.

Only one site, within the Belubula River (4th order), was classified as Type 1-highly sensitive key fish habitat waterways, Class 2-moderate key fish habitat and considered suitable habitat for supporting species of conservation significance (Table 4.1, Plate 4.5). This was attributed to the presence of a large pool with a muddy loam substrate, linked by shallow riffle sections within a broad channel (approximately 10 m wide). Aquatic vegetation was characterised by floating and emergent native taxa including *Myriophyllum* sp. and *Eleocharis* sp., while the exotic **Alisma lanceolatum* and **Phragmites* sp. were also observed. Riparian vegetation composition was dominated by willow species (**Salix* sp.) with only scattered *Eucalyptus* species present. The majority of the aquatic and riparian vegetation observed within, and adjacent to, the waterway comprised exotic taxa; however, this vegetation may still provide structures that contribute to functional in-stream fish habitat. Both the Eel-tailed Catfish and the Southern Purple-spotted Gudgeon utilise aquatic vegetation and in-steam debris for breeding and sheltering; however, the presence of a muddy loam substrate and minimal linking sections of shallow riffle substrate suggest that this site would still be unsuitable for sustaining these species and other fish populations.

Habitat characteristics were similar between mine development sites and sites downstream of the mine development, with Type 1-highly sensitive key fish habitat found upstream of, downstream of, and within the mine development along the Belubula River, Trib A and Trib L (Figure 3.1). The Belubula River, downstream of the mine development, tended to be characterised by Type 2-moderately sensitive key fish habitat (6th order; BR-06, BR-07, BR-09, BR-10), whereas Trib F4 (site F4-01) was classified as Type 3-minimally sensitive key fish habitat (Table 4.2). It is considered that the sites assessed within the mine development are unlikely to support threatened species, excluding site BR-03. The single site assessed upstream of the mine development was also considered to be unlikely

[3] Based on the Strahler (1952) method of stream ordering

to support threatened species due to a lack of aquatic habitat complexity and the absence of native riparian vegetation (Table 4.2, Figure 3.1). The remaining eight sites from the Belubula River and Trib A (Table 4.2, Figure 3.1) were also considered unlikely to support threatened species, attributed to the presence of constructed dams, muddy silty substrates, a lack of in-stream habitat features, largely cleared riparian zones, multiple erosion features, and evidence of impact from livestock (Table 4.3). While dammed areas restrict connectivity between habitats, and provide an impediment to fish passage, connectivity may occur during high flow events. However, it is considered unlikely that the system provides a high level of connectivity during low-flow conditions, and this, in conjunction with the highly disturbed condition of the aquatic environment, indicate that existing habitat is unlikely to be suitable in terms of key fish habitat and as habitat for threatened species.

Table 4.2 Summary of stream order, waterway type and waterway class along the Belubula River and associated tributaries, November 2018

Waterway	Site	Stream Order	Key Fish Habitat Waterway Type	Key Fish Habitat Waterway Class
Trib A	A-01	5th	Type 1 - Highly sensitive key fish habitat	Class 2 - Moderate key fish habitat
Trib A	B-01	3rd	Type 1 - Highly sensitive key fish habitat	Class 3 - Minimal key fish habitat
Trib A	B-02	4th	Type 1 - Highly sensitive key fish habitat	Class 3 - Minimal key fish habitat
Belubula River	BR-01	4th	Type 1 - Highly sensitive key fish habitat	Class 3 - Minimal key fish habitat
Belubula River	BR-02	3rd	Type 1 - Highly sensitive key fish habitat	Class 3 - Minimal key fish habitat
Belubula River	BR-03	4th	Type 1 - Highly sensitive key fish habitat	Class 2 - Moderate key fish habitat
Belubula River	BR-04	5th	Type 1 - Highly sensitive key fish habitat	Class 2 - Moderate key fish habitat
Belubula River	BR-05	5th	Type 1 - Highly sensitive key fish habitat	Class 2 - Moderate key fish habitat
Belubula River	BR-06	6th	Type 2 - Moderately sensitive key fish habitat	Class 2 - Moderate key fish habitat
Belubula River	BR-07	6th	Type 2 - Moderately sensitive key fish habitat	Class 2 - Moderate key fish habitat
Belubula River	BR-08	6th	Type 1 - Highly sensitive key fish habitat	Class 2 - Moderate key fish habitat
Belubula River	BR-09	6th	Type 2 - Moderately sensitive key fish habitat	Class 2 - Moderate key fish habitat
Belubula River	BR-10	6th	Type 2 - Moderately sensitive key fish habitat	Class 2 - Moderate key fish habitat
Trib F4	F4-01	2nd	Type 3 - Minimally sensitive key fish habitat	Class 4 - Unlikely key fish habitat
Trib L	L-01	3rd	Type 1 - Highly sensitive key fish habitat	Class 4 - Unlikely key fish habitat

Table 4.3 Summary of aquatic and riparian habitat condition along the Belubula River and associated tributaries, November 2018

Waterway	Site	Comments
Trib A	A-01	Series of pools along Trib A upstream of Belubula River, pools partitioned by recently constructed soil dams which impedes flow and thus fish passage, pools 20-40m x 3m, substrate mud and silt, dense cover of submerged aquatic vegetation with ~90% coverage by *Myriophyllum* sp. with fringing *Eleocharis* sp., no snags or logs, riparian vegetation largely cleared with exotic grasses the dominant feature, some impacts from livestock evident.
Trib A	B-01	Site located at pool (~45m x 6m) along a section of the 3rd order Trib A, dominated by *Typha* sp. to ~60% coverage, limited snags present, substrate comprises thick mud, moist sediment upstream and downstream, no native riparian vegetation present with the zone dominated by exotic grasses.
Trib A	B-02	Dammed area to ~ 15m with a ~15m pool located upstream of dam, aquatic vegetation comprise ~25% *Typha* sp. with dense beds of *Myriophyllum* sp. and other submerged taxa providing ~70% coverage and fringing the dam, a smaller pool contains *Myriophyllum* sp. with a coverage of ~50%, substrate mud with no gravel or bedrock, no snags, riparian vegetation comprises scattered **Salix* sp. over exotic and native grasses, dam provides some impediment to fish passage but connectivity may occur during high flow events.
Belubula River	BR-01	Series of pools (<10m x 4m), small scattered areas of bedrock, minor intermittent pools likely to be connected in moderate to high flow, gully erosion features within waterway, minimal aquatic vegetation comprising *Myriophyllum* sp. in isolated patches (<10cm x 10cm), native and exotic grasses along waterway fringe, heavily impacted by livestock.
Belubula River	BR-02	Waterway contains single pool (~40m x <5m) with rafts of emergent and floating aquatic vegetation (**Alisma* sp. (water plantain)) across ~20% of the surface, *Eleocharis* sp. emergent, riparian vegetation comprises largely exotic grasses and other weeds including **Rubus fruticosus* (blackberry), heavily impacted by livestock, a dam upstream of the site provides an impediment to fish passage.
Belubula River	BR-03	Broad channel ~10m wide containing a pool (~30m x 5m) linked by shallow riffle sections <1cm deep, floating and emergent aquatic vegetation present including **Alisma* sp., *Myriophyllum* sp., *Eleocharis* sp. and *Phragmites* sp., riparian vegetation comprises dense *Salix sp. up to ~80% coverage with some Eucalyptus spp., substrate comprises muddy loams, some in-stream snags (~<10cm) which may provide fish habitat.
Belubula River	BR-04	Series of large pools (<~50m x 5m) disconnected during low flow by sediment alluviation, defined bank and channel, aquatic vegetation minimal and limited to *Myriophyllum* sp. and other taxa providing ~10% coverage, riparian vegetation comprises *Eucalyptus viminalis* and scattered **Salix* sp., groundcover largely exotic grasses, snags limited to small logs <15cm, substrate silty mud with minor gravel covered in silt.
Belubula River	BR-05	More permanent pools ~1-5m x 50m long connected by shallow clear riffles, flow evident, substrate comprises gravel and silty mud, minimal in-stream vegetation, channels characterised by eroded banks to a width of ~2.5m and fringed by Eleocharis sp. and *Persicaria* sp., riparian vegetation comprises primarily **Salix* sp. with scattered *Eucalyptus viminalis* over exotic grasses, limited snags but evident in high flow events.
Belubula River	BR-06	Site downstream of confluence of Belubula River and Trib A, strong flow exhibited following ~50mm of rainfall, very minimal bank, channel ~5m wide and exhibiting riffle and run sections, in-stream vegetation unable to be determined due to water level, degraded riparian zone with vegetation largely absent and limited to two **Salix* sp. with exotic grasses along the bank, no snags evident.
Belubula River	BR-07	Belubula River downstream of confluence with a 5th order tributary, waterway ~8m in width, in-stream vegetation unable to be determined due to water level, no snags evident, riparian zone severely degraded with no trees except for one **Salix* sp. and characterised by exotic grasses, major impact by livestock in this area.

Table 4.3 Summary of aquatic and riparian habitat condition along the Belubula River and associated tributaries, November 2018

Waterway	Site	Comments
Belubula River	BR-08	Site located at Mid Western Highway junction downstream, flowing steadily with depth of 1.4m recorded from flood marker, channel ~10m wide and characterised by eroded banks with **Salix* sp. to ~80% coverage including within the channel, in-stream vegetation unable to be determined due to water level however some *Eleocharis* sp. was evident, riparian zone devoid of overstorey and vegetation limited to exotic grasses, no snags present however **Salix* sp. trunks and roots to ~30cm in diameter may provide habitat.
Belubula River	BR-09	Site located downstream of Newbridge Road, channel between 10m and 12m wide and inundated to within 1m of the bank, river depth unable to be determined due to water level, in-stream vegetation unable to be determined due to water level however **Salix* sp. dominant within channel, riparian vegetation limited to weeds including **Rubus fruticosus* and **Hypochaeris* sp. (cats ear), waterway severely degraded with residential inflow and rubbish evident, no snags present however **Salix* sp. trunks and roots may provide habitat.
Belubula River	BR-10	Site located at the Hobbys Yards Road crossing, channel ~10m wide and inundated to within 1.5m of the bank, in-stream vegetation unable to be determined due to water level; however, **Salix* sp. dominant within channel to ~90% coverage, riparian vegetation limited to exotic grasses and weeds including **Rubus fruticosus*, no snags present however **Salix* sp. trunks and roots may provide habitat.
Trib F4	F4-01	Channel with gully erosion and characterised by native and exotic grasses and herbs, no pools present, riparian vegetation comprises *Eucalyptus viminalis*.
Trib L	L-01	Gully erosion features within waterway (~2 m width), shallow pool (~10cm) formed following 30mm overnight rainfall, waterway supports *Typha* sp. beds (~5m x 2m), blocked culvert located downstream causing pooling upstream and downstream of the culvert, in-stream vegetation comprises exotic grasses, riparian vegetation comprises **Salix* sp. with scattered *Eucalyptus* spp., upstream areas fences and rehabilitated due to gully erosion.

4.2.2 Riparian vegetation

Results from a rapid assessment of riparian condition undertaken at 15 sites during the November 2018 field survey are summarised in the comments section of Table 4.3. Overall, riparian condition was considered poor, with riparian zones generally degraded and impacted to some degree by agriculture and livestock, and exhibiting erosive gully features within the waterway channel and along the banks. A defined bank was absent at some sites, for example BR-06 (6th order) within the Belubula River (Plate 4.6). The majority of sites displayed little to no native vegetation cover, with introduced willow species the dominant tree along most waterways (Appendix A). Additionally, some sites were essentially devoid of vegetation (eg BR-02, 3rd order) (Plate 4.6). At a number of sites, Manna Gum (*Eucalyptus viminalis*) and other *Eucalyptus* species formed a component of the riparian vegetation; however, this comprised limited to very sparse open woodlands at some sites, and individual trees at others (A-01, 5th order; BR-06, 6th order) (Plate 4.7). The understorey at the majority of sites was characterised by exotic grasses along the bank and within the waterway channel, and usually comprised other weeds including blackberry (*Rubus fruticosus*), which is listed as a weed of national significance. Blackberry was noted at three sites, but is likely to be more widespread, particularly within waterways where surface water pools after heavy rainfall.

Although exotic plants were dominant over native vegetation within the riparian zone, there was some habitat continuity at a small number of the sites which may provide vegetative cover and structural complexity. Three sites along the Belubula River (BR-03, BR-08, BR-09, 4th to 6th order) were characterised by approximately 80% vegetation cover which, in conjunction with in-stream logs and other debris, may provide habitat for some fish species (Plate 4.8, Plate 4.5). It was considered possible that site BR-03 (4th order) may provide appropriate key fish habitat (Type 2, Class 2, Plate 4.5). Some land management measures were noted upstream of L-01 (3rd order), located along Trib L, with fencing and rehabilitation of the waterway observed as a result of gully erosion along the bed and banks. However, currently, there are limited mitigation measures in place within the riparian zone to restrict impacts from agriculture or livestock, meaning that the limited potential habitat is likely to be subject to ongoing pressures without intervention.

Plate 4.5 Waterway and riparian condition at site BR-03 (4th order), Belubula River, November 2018

Plate 4.6 Waterway and riparian condition at sites BR-06 (6th order; left) and BR-02 (3rd order; right), Belubula River, November 2018

Plate 4.7 Waterway and riparian condition at site A-01 (Trib A, 5th order; left) and BR-06 (Belubula River, 6th order; right), November 2018

Plate 4.8 Waterway and riparian condition at sites BR-08 (6th order; left) and BR-09 (6th order; right), Belubula River, November 2018

5 Environmental receptors and impacts

5.1 Environmental receptors

The construction of the McPhillamys Project is expected to require the mining of an open cut pit and the construction of a waste emplacement area, water storage/sediment basins, a TSF, and associated infrastructure. The construction of the TSF will occur at the headwater of the Belubula River, while the construction of other infrastructure will occur across associated minor tributaries. Based on the findings of the aquatic ecology assessment, the primary environmental receptors identified in relation to potential impacts associated with mine development comprise:

- water and sediment quality, downstream of construction areas;
- key fish habitat;
- aquatic biodiversity (eg algae, macrophytes, aquatic invertebrates and aquatic vertebrates); and
- native plants inhabiting the riparian zone.

5.2 Potential impacts

Overall, it is considered unlikely that existing habitat within the Belubula River and associated tributaries would support species of conservation significance, with only one site with the potential to contain sufficient features to support threatened species. This is attributed to high levels of existing environmental degradation and a lack of on-going mitigation or management across the local region. Therefore, existing habitat condition, in conjunction with the current distribution of threatened species, indicates that there is not expected to be a significant ecological risk as a result of mine development. However, the potential does exist for direct and indirect impacts to environmental receptors to occur along the Belubula River and associated tributaries, as a result of the proposed mine development, listed below:

- Potential direct impacts:
  - decrease in short-term water and sediment quality (impacting aquatic biodiversity);
  - aquatic and riparian habitat removal and habitat fragmentation (impacting key fish habitat); and
  - reduction or cessation in surface water flow between the headwater of the Belubula River and Trib A (impacting key fish habitat).
- Potential indirect impacts:
  - decrease in medium-term water and sediment quality (impacting aquatic biodiversity);
  - breach of water quality objectives (ie elevated salinity and/or metal concentrations) as a result of seepage to groundwater, unplanned discharge to surface water, runoff, or failure of the surface water management system (impacting aquatic biodiversity);
  - potential for reduction in surface water flow (impacting key fish habitat);
  - altered hydrology within the Belubula River during high-flow events (impacting key fish habitat);
  - erosion, siltation and degradation of the riparian zone, including an increase in instability of waterway banks and beds (impacting key fish habitat and aquatic biodiversity);
  - reduced recruitment of native riparian plants, including potential loss of conservation significant vegetation and habitat (impacting riparian biodiversity); and
  - contribution to key threatening processes (impacting key fish habitat and aquatic biodiversity).

6 Impact avoidance, mitigation and management

One site characterised as having sufficient features to warrant being classified as 'Class 2-moderate key fish habitat', will be removed as part of TSF construction (BR-03) (Figure 1.3, Figure 6.1). However, there is currently little connectivity between sites during low-flow conditions, attributed to the ephemeral nature of the waterways and the degree of landscape modification currently experienced by the broader upstream area. Therefore, it is considered unlikely that the majority of waterways would provide suitable habitat to support migration and breeding among local populations of resident native aquatic fauna. Overall, it is considered unlikely that the mine development would impact extensively on local habitat loss and fragmentation.

In terms of indirect impacts, there is the potential that surface water flow to Carcoar Dam, and other downstream areas, will decrease as a result of construction of the TSF, associated water storage facilities and other infrastructure. The Surface Water Assessment undertaken for the mine development (Hydro Engineering & Consulting Pty Ltd, 2019) assessed the potential reduction in surface water flow as a result of mining and infrastructure placement. During mining operations, it is estimated that the flows within the Belubula River will reduce, on average, by:

- 9% at the Mid Western Highway old gauging station (GS 412404);
- 4% at Carcoar Dam (to 5,595 ML/year); and
- 22% at the proposed Belubula River downstream gauging station.

Post-mining, all mining areas, except the final void, will be regraded to a stable landform, revegetated and rehabilitated. A number of permanent clean water diversion channels will be constructed to allow a free-draining landform which will then contribute surface water inputs to the Belubula River catchment. Post-mining, is estimated that surface water flow will reduce (from current baseline conditions) within the Belubula River, on average, by:

- 1% at the Mid Western Highway old gauging station (GS 412404);
- 0.5% at Carcoar Dam (to 5,809 ML/year); and
- 2.5% at the proposed Belubula River downstream gauging station.

The results of the groundwater model, undertaken as part of the Groundwater Assessment (EMM Consulting Pty Ltd, 2019), predict that groundwater baseflow to Trib A and the Belubula River (upstream of Trib A) may reduce by 15%. However, as groundwater is currently estimated to contribute approximately 5% to overall surface flows, this predicted reduction in baseflow is minor in comparison to the reduced flow as a result of reduced catchment.

The construction and operation of the mine development may result in fish passage impediment; in particular, the conservation significant fish species within the Carcoar Dam, the Lachlan River EEC, and the Great Cumbung Swamp wetlands. However, the already existing lack of local connectivity during low-flow conditions, the distinct absence of species of conservation significance within the Belubula River and associated tributaries (Table 4.1) (Department of Primary Industries, 2019), and the physical barrier (Carcoar Dam) between the mine development and known areas of conservation significance means impacts downstream of the Carcoar Dam should be highly unlikely. Impacts to conservation significant fish species within the Carcoar Dam are also possible, with Silver Perch and Murray Cod stocked as part of conservation initiatives (Department of Primary Industries, 2019). However, regional impacts further downstream of Carcoar Dam are unlikely, with the dam itself providing a physical barrier to upstream migration and connectivity. In terms of regional downstream migration, impacts are also unlikely due to the infrequency in which the Lachlan River joins the Murrumbidgee River, and the location of the Great Cumbung Swamp wetlands which provide a terminus and an additional physical migration barrier.

With regard to the riparian zone, erosion and degradation, leading to instability of waterway banks and beds and an increase in sedimentation, may occur over the short to medium-term due to construction and operation of the mine development. This is likely to also affect the aquatic environment. While reduced recruitment of native riparian plants has the potential to occur, the loss of conservation significant riparian vegetation and habitat is unlikely due to its absence within the local area. It is also unlikely that riparian vegetation currently provides habitat to threatened flora or fauna species, and comprises mostly exotic taxa (Table 4.3) (EnviroKey Pty Ltd, 2014) (EMM Consulting Pty Ltd, 2018), although some habitat complexity is provided by exotic plants in-stream. No EPBC Act-listed threatened species and communities, or Ramsar wetlands of international importance ('Ramsar wetlands') identified in the aquatic ecology assessment have been documented as occurring within the mine development, and therefore are unlikely to be impacted as a result. Overall, impacts to native riparian vegetation communities are anticipated to be minor and localised.

With regard to direct impacts, habitat removal and fragmentation within the mine development has been substantially reduced since the preparation of the Preliminary Environmental Assessment (PEA), with Trib A and sections of the Belubula River, downstream of Trib A, removed from the disturbance footprint. The Trib A catchment, as well as a number of other tributaries, contributes higher surface water flow to the Belubula River than the headwater of the river itself; therefore, there will only be a minor reduction to Trib A catchment contribution. The catchment size of these tributaries (Trib A to Trib K) totals 24.4 km^2, in comparison to the catchment size of the Belubula River at the confluence with Trib A (~17.5 km^2) (EMM Consulting Pty Ltd, 2019). Additionally, areas downstream of the confluence of Trib A and the Belubula River have been observed to hold surface water for longer periods in comparison to areas on the Belubula upstream of the confluence. During the operations stage, flows downstream of the mine development, in particular to Carcoar Dam, will only be marginally reduced (4%) (Hydro Engineering & Consulting Pty Ltd, 2019). Overall, the primary direct impact on surface flow as a result of the mine development within the Belubula River will be as a result of a reduction in catchment size (Hydro Engineering & Consulting Pty Ltd, 2019).

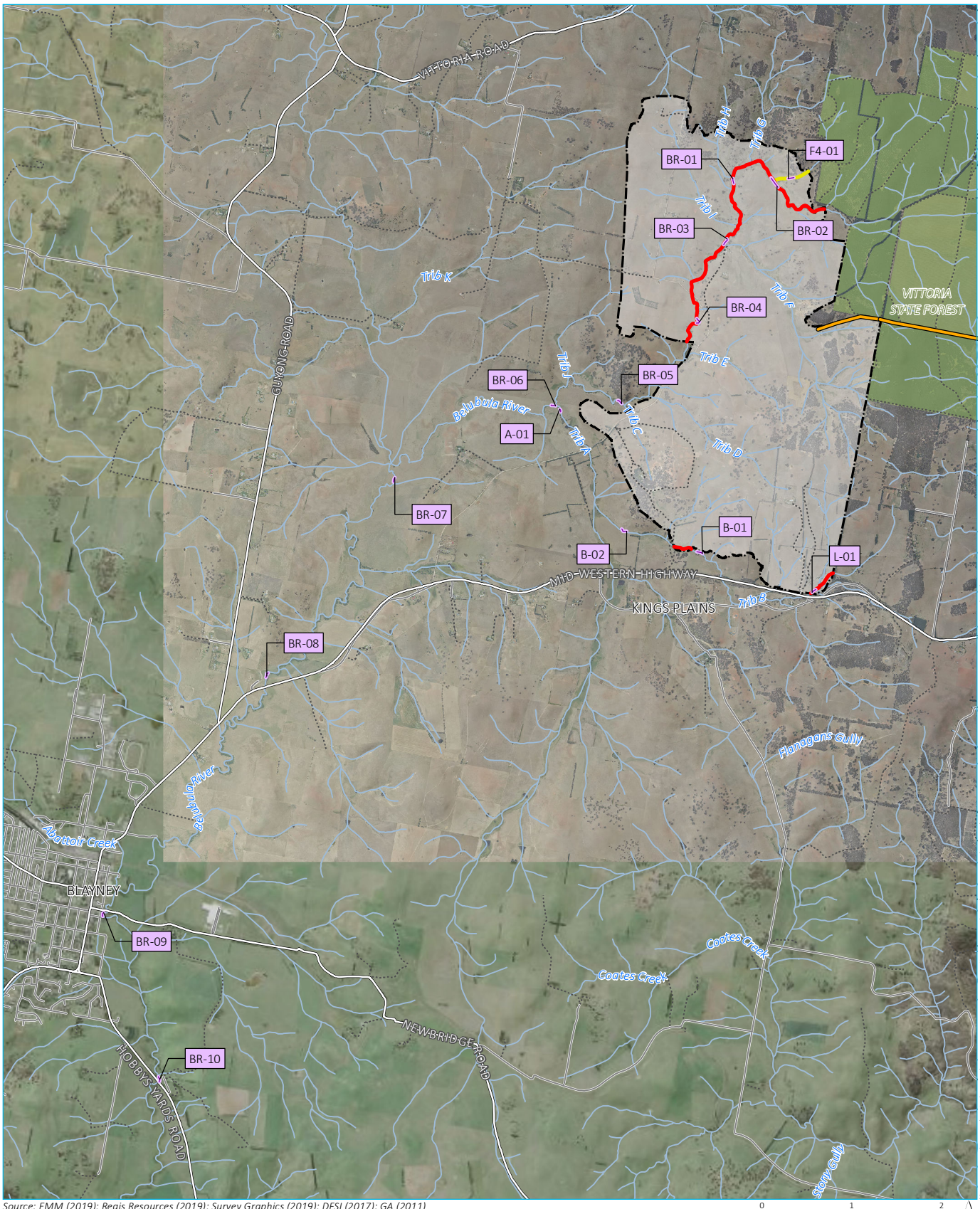
In terms of direct and indirect impacts to water quality, the mine development will be designed such that all water will be contained on site (ie no discharge site), with water storage facilities allowing the capture and recirculating of water. There is a 1% risk of discharge from the water storage areas per year, and no changes to the water quality of the Belubula River and Carcoar Dam are expected (Hydro Engineering & Consulting Pty Ltd, 2019). Water storage facilities have been designed to contain water under a number of historical climate scenarios, with more high-risk facilities, including the TSF (ATC Williams, 2019) and the secondary water management facility, holding the required capacities (Hydro Engineering & Consulting Pty Ltd, 2019). As part of the water management system to be implemented across the mine development, clean water from the catchment upstream of the TSF will be captured and diverted to the Belubula River, downstream of the mine development (Hydro Engineering & Consulting Pty Ltd, 2019). With regard to seepage emanating from the TSF, the worst-case scenario is that with no mitigation (eg seepage interception bores), seepage is predicted to flow south and southwest towards the Belubula River. However, the distance that the seepage will migrate over 100 years is approximately 50 m, with the chemical composition of the seepage likely to become highly dilute along the flow path (EMM Consulting Pty Ltd, 2019). As such, concentrations of metals and trace elements in seepage that may migrate through to the Belubula River will be below existing surface water quality concentrations, as well as ANZECC & ARMCANZ (2000) guideline triggers values for freshwater ecosystems and livestock drinking water. This will occur irrespective of the implementation of seepage management and mitigation. Once groundwater discharges to the Belubula River, any seepage that may be present within the groundwater will become further diluted, given that groundwater discharge is predicted to represent approximately 3-5% of the overall contribution to surface flow in the Belubula River. The installation and operation of seepage management system will reduce the likelihood of seepage migrating to the Belubula River and, following completion of mining and tailings placement, the TSF will be capped to facilitate surface water drainage and prevent ponding of water. This will limit potential rainfall infiltration into the TSF, and seepage migrating out of the TSF over the longer-term (ATC Williams, 2019). Further detail on the TSF seepage management system, including discussion on the effectiveness of the seepage interception trench, can be found in ATC Williams (2019).

To address potential breaches of water quality objectives as a result of seepage to groundwater, unplanned discharge to surface water, runoff, or failure of the surface water management system, a Water Management Plan (WMP) will be implemented The WMP will form part of the environmental management system, and will document mitigation and management measures, surface and groundwater monitoring programs, reporting requirements, spill management and response, water quality trigger levels, corrective actions, contingencies, and responsibilities. The surface water and groundwater monitoring programs will incorporate and update the existing monitoring network, monitoring frequencies and water quality constituents. Reporting frameworks will be prepared in accordance with licensing and agency requirements. Trigger levels for water quality parameters will be developed as part of the WMP to assist in early identification of water quality trends (including TSF seepage migration). The monitoring program will be prepared in accordance with the approved environment protection licence (EPL), once enacted. A trigger action response plan will be developed as part of the WMP and will outline the actions and responses required in the event that the project commitments, thresholds, objectives and approvals conditions will not be achieved.

In terms of direct and indirect impacts to sediment quality, runoff from disturbed areas and rehabilitation programs will be the established and managed as part of the water management system, which would be in place during operations only and would incorporate erosion and sediment control measures designed in accordance with Landcom (2004) and DECCW (2008), and may incorporate the following:

- minimising surface disturbance and restricting access to undisturbed areas;
- progressive rehabilitation/stabilisation of mine infrastructure areas;
- separation of runoff from disturbed and undisturbed areas where practicable;
- construction of surface drains to control and manage surface runoff; and
- construction of sediment dams to contain runoff up to a specified design criterion.

An Erosion and Sediment Control Plan would be developed to detail the erosion and sediment control measures to be implemented during construction and operations stages; however, it should be noted that the Erosion and Sediment Control Plan and the water management system, are yet to be developed/finalised. As a result of the above mitigation, it is unlikely that additional sedimentation, erosion and degradation of the catchment would occur, and impacts to recruitment of native riparian plants should be minimal.



Source: EMM (2019); Regis Resources (2019); Survey Graphics (2019); DFSI (2017); GA (2011)

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GDA 1994 MGA Zone 55

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KEY

- Pipeline corridor
- Disturbance footprint
- Key fish habitat sample site

Waterway type classification

- Type 1
- Type 3

Existing environment

- Main road
- Local road
- Vehicular track
- Watercourse/drainage line
- State forest

Key fish habitat waterway type classification within the disturbance footprint

McPhillamys Gold Project
Aquatic ecology assessment
Figure 4.3

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7 Summary and recommendations

7.1 Summary

There is unlikely to be any significant impact, as a result of the mine development, to threatened species, populations or ecological communities listed under the FM Act or EPBC Act (Table 4.1), within the aquatic or riparian environments of the Belubula River and associated tributaries, upstream of Carcoar Dam. It is considered that sufficient in-field survey has been undertaken within the vicinity of the mine development, and that additional survey is unlikely to yield suitable habitat or taxa of conservation significance. Furthermore, assessed habitat, and local conditions in general, are highly degraded and influenced by pastoralism and agricultural uses, limiting their functionality as key fish habitat. In terms of habitat between the mine development and the Carcoar Dam, connectivity may occur during high flow events. However, it is considered unlikely that the system provides a high level of connectivity during low-flow conditions, and this, in conjunction with the highly disturbed condition of the aquatic environment, indicate that existing habitat is unlikely to be suitable in terms of key fish habitat and as habitat for threatened species. With regard to surface water flow, downstream of the mine development, a reduction in flow will occur at the headwater of the Belubula River, resulting in a 4% reduction in median annual flow to Carcoar Dam, a negligible impact that is unlikely to affect flows received by the Carcoar Dam. In addition, a number of monitoring and management plans will be development and implemented to reduce the likelihood of impacts occurring to water and sediment quality, including erosion and sedimentation. Overall, it is unlikely that direct and indirect impacts resulting from the mine development will contribute to exacerbation of key threatening processes within the broader area.

7.2 Recommendations

Regis is currently considering a range of biodiversity offset and habitat enhancement initiatives to ensure biodiversity values are maintained or improved in the long-term. Relevant to aquatic and riparian ecology, several recommendations are provided for consideration, providing guidance on future research, monitoring (where applicable) and environmental management including:

- Ongoing monitoring and assessment of mine development impacts on aquatic and riparian ecology;
- Implement appropriate aquatic rehabilitation programs (in conjunction with existing landowners) along waterway banks and within the riparian zone, consisting of weed management, native vegetation planning, erosion control/prevention, and fencing of semi-permanent pools and/or springs;
- Where possible, existing dams, weirs or other in-stream structures, not critical to mine development function, should be removed to increase the potential for movement of aquatic fauna;
- Implement an aquatic and riparian zone rehabilitation program;
- Consider developing site-specific water quality criteria for use in future monitoring programs;
- Continue consultation with the DPI Fisheries to determine the most appropriate aquatic habitat offsets, in alignment with *NSW Biodiversity Offsets Policy for Major Projects* and *Biodiversity Offsets Policy for Major Projects Fact sheet: Aquatic biodiversity*; and
- Engage with stakeholders to promote catchment improvement programs for the Belubula River, above Carcoar Dam.

8 Ecological offset strategy

DPI Fisheries has indicated that an aquatic ecology offset strategy will be required as part of the McPhillamys Project in accordance with *Biodiversity Offsets Policy for Major Projects Fact sheet: Aquatic biodiversity*. In terms of aquatic biodiversity, it is acknowledged that an offset strategy should be implemented:

- within the Belubula River catchment;
- within "like for like" habitat;
- within the same or a similar habitat in the same catchment that is more threatened than the habitat being impacted on; and
- as part of an offset site, as versus implementing supplementary measures.

In the event that the above criteria cannot be met, then funds may be provided towards implementing supplementary measures which provide additional flexibility in fulfilling offset requirements. These may include:

- implementing actions outlined in relevant threatened species recovery plans or Priorities Action Statement in the absence of threatened species recovery plans;
    - eg Priorities Action Statement – Actions for the Southern Purple Spotted Gudgeon.
- Implementing actions that contribute to threat abatement plans;
    - eg Threat Abatement Plan – large woody debris.
- undertaking biodiversity research and survey programs identified by the DPI Fisheries; and/or
- rehabilitating degraded aquatic habitat.

In the context of the McPhillamys Project and, due to the high level of habitat disturbance and fragmentation currently existing within the Belubula River catchment, it is likely that supplementary measures would form a key part of any offset strategy. For example, Regis could provide funding towards existing habitat mapping programs within the broader region (eg below Carcoar Dam), undertake aquatic and riparian habitat rehabilitation along the Belubula River, and/or remove existing barriers to fish passage along the Belubula River, not critical to mine development function. In the event that a monetary contribution is proposed in place of offsets occurring within the same or a similar habitat to that being impacted, then the area of habitat loss within the mine development ('disturbance footprint') would be calculated for impacted waterways.

The DPI (2014) requires that a minimum 2:1 offset occurs for Type 1 to Type 3 key fish habitats to redress both the direct and indirect impacts of development. Within waterways assessed by EMM, approximately 1.8 km of Type 1 highly sensitive key fish habitat and approximately 0.4 km of Type 3 minimally sensitive key fish habitat was identified within the disturbance footprint (Figure 6.1). This key fish habitat will be subject to direct impacts as a result of the placement of the TSF (Figure 1.3). It should be noted that these lengths do not directly relate to the area calculations required by the DPI (2014). Regis will therefore carry out further field verification (ie ground truth stream widths) and/or spatial data analysis to quantify the areas of key fish habit to be removed in consultation with DPI Fisheries. In addition, it should be noted that:

- any offset strategy will be developed in consultation with the DPI Fisheries, and relevant technical staff, to determine whether on site improvement or contribution to priorities identified by DPI Fisheries is the preferred option; and
- the offset strategy will be developed following approval of the McPhillamys Project.

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Appendix A

Site photographs, November 2018

Plate A.1 Waterway and riparian condition at site B-01 (Trib A, 3rd order), November 2018.

Plate A.2 Waterway and riparian condition at site B-02 (Trib A, 4th order), November 2018.

Plate A.3 Waterway and riparian condition at site BR-01 (Belubula River, 4th order), November 2018.

Plate A.4 Waterway and riparian condition at site BR-04 (Belubula River, 5th order), November 2018.

Plate A.5 Waterway and riparian condition at site BR-07 (Belubula River, 6th order), November 2018.

Appendix B

Aquatic ecology assessment proforma

Aquatic survey data sheet – Waterway class and type

Project Number/Name:	
Waterway:	
Date:	Personnel:
Survey Site (ID):	GPS Coordinate:
Easting/northing start:	Easting/northing end:
Photograph – upstream:	Photograph – downstream:
Photograph – bed:	Photograph – banks:

Key fish habitat (KFH) – waterway type assessment

Component	Present?	Component	Present?	Component	Present?
Type 1 - Highly sensitive key fish habitat		Type 2 – Moderately sensitive key fish habitat		Type 3 – Minimally sensitive key fish habitat	
Posidonia australis (a seagrass)		*Zostera*, *Heterozostera*, *Halophila* and *Ruppia* species of seagrass beds <5m^2 in area		Unstable or unvegetated sand or mud substrate, coastal and estuarine sandy beaches with minimal or no in-fauna	
Zostera/Heterozostera/*Halophila*/*Ruppia* species of seagrass beds >5m^2 in area		Mangroves		Coastal and freshwater habitats not included in TYPES 1 or 2	
Coastal saltmarsh >5m^2 in area		Coastal saltmarsh <5m^2 in area		Ephemeral aquatic habitat not supporting native aquatic or wetland vegetation	
Coral communities		Marine macroalgae such as *Ecklonia* and *Sargassum* species		Notes: For the purposes of these policy and guidelines the following are not considered key fish habitat:	
Coastal lakes and lagoons that have a natural opening and closing regime (i.e. are not permanently open or artificially closed or are subject to one off unauthorised openings)		Estuarine and marine rocky reefs		First and second order streams on gaining streams (based on the Strahler method of stream ordering)	
Marine park, an aquatic reserve or intertidal protected area		Coastal lakes and lagoons that are permanently open or subject to artificial opening via agreed management arrangements (e.g. managed in line with an entrance management plan)		Farm dams on first and second order streams or unmapped gullies	
SEPP 14 coastal wetlands, wetlands recognised under international agreements (e.g. Ramsar,		Aquatic habitat within 100 m of marine park, aquatic reserve or intertidal protected area		Agricultural and urban drains	

JAMBA, CAMBA, ROKAMBA wetlands), wetlands listed in the Directory of Important Wetlands of Australia		
Freshwater habitats that contain in-stream gravel beds, rocks greater than 500 mm in two dimensions, snags greater than 300 mm in diameter or 3 m in length, or native aquatic plants	Stable intertidal sand/mud flats, coastal and estuarine sandy beaches with large populations of in-fauna	Urban or other artificial ponds (e.g. evaporation basins, aquaculture ponds)
Any known or expected protected or threatened species habitat or area of declared 'critical habitat' under the FM Act	Freshwater habitats and brackish wetlands, lakes and lagoons other than those defined in TYPE 1	Sections of stream that have been concrete-lined or piped (not including a waterway crossing)
Mound springs	Weir pools and dams up to full supply level where the weir or dam is across a natural waterway	Canal estates

Key fish habitat (KFH) – waterway class assessment

Classification	Characteristics of waterway class	Present?
Class 1 – major key fish habitat	Marine or estuarine waterway or permanently flowing or flooded freshwater waterway (e.g. river or major creek), habitat of a threatened or protected fish species or 'critical habitat'.	
Class 2 – moderate key fish habitat	Generally named intermittently flowing stream, creek or waterway with clearly defined bed and banks, semi-permanent to permanent water in pools or in connected wetland areas. Freshwater aquatic vegetation is present. Type 1 and Type 2 habitats present.	
Class 3 – minimal key fish habitat	Named or unnamed waterway with intermittent flow and sporadic refuge, breeding or feeding areas for aquatic fauna (e.g. fish, yabbies). Semi-permanent pools form within the waterway or adjacent wetlands after a rain event. Otherwise, any minor waterway that interconnects with wetlands or other Class 1-3 fish habitats.	
Class 4 – unlikely key fish habitat	Generally unnamed waterway with intermittent flow following rain events only, little or no defined drainage channel, little or no flow or free-standing water or pools post-rain events (e.g. dry gullies, shallow floodplain depressions with no aquatic flora).	

Notes:

Appendix C

Results of the database searches

Table C.1 Summary of database search results

Group	Family	Taxa	Vernacular	Distance From Project (km)	Conservation Code			Likelihood	Restricted?
					BC Act	FM Act	EPBC Act		
Amphibian	Hylidae	*Litoria aurea*	Green and Golden Bell Frog	-	Endangered	-	Vulnerable	Possible	Yes
Amphibian	Hylidae	*Litoria booroolongensis*	Booroolong Frog	-	Endangered	-	Endangered	Possible	Yes
Amphibian	Hylidae	*Litoria castanea*	Yellow-spotted Tree Frog	-	Critically Endangered	-	Endangered	Likely	Yes
Avifauna	Accipitridae	*Haliaeetus leucogaster*	White-Bellied Sea-Eagle	-	Vulnerable	-	Marine	Likely	No
Avifauna	Apodidae	*Apus pacificus*	Fork-tailed Swift	-	-	-	Migratory Marine/ Marine	Likely	No
Avifauna	Apodidae	*Hirundapus caudacutus*	White-throated Needletail	-	-	-	Migratory Terrestrial/ Marine	Likely	No
Avifauna	Ardeidae	*Ardea alba*	Great Egret	-	-	-	Marine	Possible	No
Avifauna	Ardeidae	*Ardea ibis*	Cattle Egret	-	-	-	Marine	Possible	No
Avifauna	Cuculidae	*Chrysococcyx osculans*	Black-eared Cuckoo	-	-	-	Marine	Likely	No
Avifauna	Dicruridae	*Myiagra cyanoleuca*	Satin Flycatcher	-	-	-	Migratory Terrestrial/ Marine	Likely	No
Avifauna	Dicruridae	*Rhipidura rufifrons*	Rufous Fantail	-	-	-	Migratory Terrestrial/ Marine	Likely	No
Avifauna	Megapodiidae	*Leipoa ocellata*	Malleefowl	-	Endangered	-	Vulnerable	Possible	No
Avifauna	Meliphagidae	*Anthochaera phrygia*	Regent Honeyeater	-	Critically Endangered	-	Critically Endangered	Likely	No
Avifauna	Meliphagidae	*Grantiella picta*	Painted Honeyeater	-	Vulnerable	-	Vulnerable	Likely	No
Avifauna	Meropidae	*Merops ornatus*	Rainbow Bee-eater	-	-	-	Marine	Possible	No
Avifauna	Motacillidae	*Motacilla flava*	Yellow Wagtail	-	-	-	Migratory Terrestrial/ Marine	Possible	No
Avifauna	Psittacidae	*Lathamus discolor*	Swift Parrot	-	Endangered	-	Critically Endangered/ Marine	Likely	No

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Group	Family	Taxa	Vernacular	Distance From Project (km)	Conservation Code			Likelihood	Restricted?
					BC Act	FM Act	EPBC Act		
Avifauna	Psittacidae	*Polytelis swainsonii*	Superb Parrot	-	Vulnerable	-	Vulnerable	Likely	No
Avifauna	Rostratulidae	*Rostratula australis*	Australian Painted Snipe	-	Endangered	-	Endangered	Possible	No
Avifauna	Scolopacidae	*Actitis hypoleucos*	Common Sandpiper	-	-	-	Migratory Wetlands/ Marine	Possible	No
Avifauna	Scolopacidae	*Calidris acuminata*	Sharp-tailed Sandpiper	-	-	-	Migratory Wetlands/ Marine	Possible	No
Avifauna	Scolopacidae	*Calidris ferruginea*	Curlew Sandpiper	-	Endangered	-	Critically Endangered/ Migratory Wetlands/ Marine	Possible	No
Avifauna	Scolopacidae	*Calidris melanotos*	Pectoral Sandpiper	-	-	-	Migratory Wetlands/ Marine	Possible	No
Avifauna	Scolopacidae	*Gallinago hardwickii*	Japanese Snipe	-	-	-	Migratory Wetlands/ Marine	Possible	No
Avifauna	Scolopacidae	*Numenius madagascariensis*	Eastern Curlew, Far Eastern Curlew	-	-	-	Critically Endangered/ Migratory Wetlands/ Marine	Possible	No
Fish	Eleotridae	*Mogurnda adspersa*	Southern Purple-spotted Gudgeon	-	-	Endangered	-	Possible	Yes
Fish	Percichthyidae	*Maccullochella macquariensis*	Trout Cod	-	-	Endangered	Endangered	Possible	Yes
Fish	Percichthyidae	*Maccullochella peelii*	Murray Cod	-	-	-	Vulnerable	Possible	Yes
Fish	Percichthyidae	*Macquaria australasica*	Macquarie Perch	-	-	Endangered	Endangered	Possible	Yes
Fish	Plotosidae	*Tandanus tandanus*[+]	Eel-tailed Catfish	-	-	Endangered	-	Possible	Yes
Mammal	Dasyuridae	*Dasyurus maculatus*	Spot-tailed Quoll	-	Vulnerable	-	Endangered	Possible	No
Mammal	Macropodidae	*Petrogale penicillata*	Brush-tailed Rock-wallaby	-	Endangered	-	Vulnerable	Possible	Yes

Table C.1 Summary of database search results

Group	Family	Taxa	Vernacular	Distance From Project (km)	Conservation Code			Likelihood	Restricted?
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Mammal	Petauridae	*Petauroides volans*	Greater Glider	-	Endangered	-	Vulnerable	Possible	Yes
Mammal	Phascolarctidae	*Phascolarctos cinereus*	Koala	-	Vulnerable	-	Vulnerable	Possible	Yes
Mammal	Pteropodidae	*Pteropus poliocephalus*	Grey-headed Flying-fox	-	Vulnerable	-	Vulnerable	Possible	No
Mammal	Vespertilionidae	*Chalinolobus dwyeri*	Large-eared Pied Bat	-	Vulnerable	-	Vulnerable	Possible	No
Reptile	Pygopodidae	*Aprasia parapulchella*	Pink-tailed Legless Lizard	-	Vulnerable	-	Vulnerable	Possible	No
Reptile	Pygopodidae	*Delma impar*	Striped Legless Lizard	-	Vulnerable	-	Vulnerable	Possible	No
Plant	Asteraceae	*Ammobium craspedioides*	Yass Daisy	-	Vulnerable	-	Vulnerable	Unlikely	Yes
Plant	Asteraceae	*Leucochrysum albicans var. tricolor*	Hoary Sunray	-	-	-	Endangered	Possible	Yes
Plant	Brassicaceae	*Lepidium hyssopifolium*	Aromatic Peppercress	-	Endangered	-	Endangered	Unlikely	Yes
Plant	Fabaceae	*Swainsona recta*	Small Purple-pea	-	Endangered	-	Endangered	Possible	Yes
Plant	Myrtaceae	*Eucalyptus aggregata*	Black Gum	-	Vulnerable	-	Vulnerable	Likely	No
Plant	Myrtaceae	*Eucalyptus pulverulenta*	Silver-Leaved Gum	-	Vulnerable	-	Vulnerable	Possible	No
Plant	Orobanchaceae	*Euphrasia arguta*	an eyebright	-	Critically Endangered	-	Critically Endangered	Possible	Yes
Plant	Poaceae	*Dichanthium setosum*	Bluegrass	-	Vulnerable	-	Vulnerable	Possible	Yes
Plant	Rutaceae	*Philotheca ericifolia*	-	-	-	-	Vulnerable	Possible	Yes
Plant	Rutaceae	*Zieria obcordata*	-	-	Endangered	-	Endangered	Unlikely	Yes
Plant	Santalaceae	*Thesium australe*	Austral Toadflax	-	Vulnerable	-	Vulnerable	Possible	Yes
Ecosystem	-	-	Natural Temperate Grassland Of The South Eastern Highlands	Known from project area	-	-	Critically Endangered TEC	Likely	Yes

Table C.1 Summary of database search results

Group	Family	Taxa	Vernacular	Distance From Project (km)	Conservation Code			Likelihood	Restricted?
					BC Act	FM Act	EPBC Act		
Ecosystem	-	-	White Box-Yellow Box-Blakely's Red Gum Grassy Woodland And Derived Native Grassland	Known from project area	-	-	Critically Endangered TEC	Likely	Yes
Ecosystem	-	-	Banrock Station Wetland Complex	800 - 900km upstream	-	-	Wetlands of International Importance	-	Yes
Ecosystem	-	-	Hattah-Kulkyne Lakes	600 - 700km upstream	-	-	Wetlands of International Importance	-	Yes
Ecosystem	-	-	Riverland	700 - 800km upstream	-	-	Wetlands of International Importance	-	Yes
Ecosystem	-	-	The Coorong, Lake Alexandrina And Lake Albert Wetlands	900 - 1000km upstream	-	-	Wetlands of International Importance	-	Yes
Ecosystem	-	-	The Macquarie Marshes	200 - 300km upstream	-	-	Wetlands of International Importance	-	Yes