Appendix E

Aquatic Ecology and Stygofauna Assessment

WINCHESTER SOUTH PROJECT

Environmental Impact Statement

WHITEHAVEN COAL

Resource Strategies

Winchester South Project

Aquatic Ecology and Stygofauna Assessment

Prepared for: Whitehaven WS Pty Ltd

Prepared by Ecological Service Professionals Pty Ltd

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Executive Summary

Introduction and Scope of Assessment

This aquatic ecology assessment report has been prepared by Ecological Service Professionals (ESP) for Whitehaven WS Pty Ltd (Whitehaven WS), a wholly owned subsidiary of Whitehaven Coal Limited, and forms part of the Environmental Impact Statement (EIS) for the Winchester South Project (the Project). The Project is an open cut coal mine and associated infrastructure within the Bowen Basin, located approximately 30 kilometres (km) south-east of Moranbah, within the Isaac Regional Council Local Government Area.

The Project involves the development of an open cut coal mine in an existing mining precinct for export of coal products. The Project is forecast to extract approximately 15 million tonnes per annum (Mtpa) of run-of-mine (ROM) coal, with a forecast peak extraction of up to 17 Mtpa, for approximately 30 years. The coal resource would be mined by open cut mining methods, with product coal to be transported by rail to port for export.

The Coordinator-General declared the Project to be a 'coordinated project for which an EIS is required' under section 26(1)(a) of the *State Development and Public Works Organisation Act 1971* (SDPWO Act). The EIS process under Part 4 of the SDPWO Act has been accredited under the Bilateral Agreement for the assessment of the Project under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). The EIS therefore addresses both the *Environmental Protection Act 1994* (EP Act) (State) and EPBC Act (Commonwealth) matters, in accordance with the Terms of Reference (TOR) for the EIS, which was issued in September 2019.

This report documents the current condition of the aquatic ecosystems in the vicinity of the Project and provides an assessment of the potential impacts of the Project on aquatic ecology. Specifically, it provides:

- a summary of aquatic flora and fauna (including aquatic macroinvertebrates, fish, reptiles and mammals) as informed by the desktop review and results from comprehensive seasonal surveys,
- a detailed assessment of aquatic ecological condition of waterways, wetlands and potential surface-expression groundwater dependent ecosystems (GDEs) in the vicinity of the Project,
- an assessment of stygofauna communities as informed by the desktop review and results from a pilot study,
- an assessment of the potential likelihood of occurrence of any aquatic Matters of National Environmental Significance (MNES) and Matters of State Environmental Significance (MSES),
- an assessment of the potential indirect, direct and cumulative impacts of the Project on aquatic ecology and stygofauna,
- a summary of avoidance and mitigation measure to minimise impacts, and

- an assessment of any residual significant impacts associated with the Project in accordance with the *Matters of National Environmental Significance: Significant Impact Guidelines 1.1* and the *Queensland Environmental Offsets Policy – Significant Residual Impact Guideline*.

Methods

The Project area comprises the open cut extent, waste rock emplacement areas and associated infrastructure areas, including the infrastructure corridor (e.g. raw water supply pipeline, electricity transmission line and mine access road). The Study area for the Project includes waterways, farm dams and wetlands upstream of, adjacent to, within and downstream (i.e. in the receiving environment) of the Project area, including the Isaac River and its tributaries (including Cherwell Creek), and Ripstone Creek and its tributaries. The Study area consists of ephemeral streams which are dry for most of the year and flow for short periods during significant rain events. Several farm dams are also scattered throughout, with some palustrine wetlands located within the Study area. The Isaac River is located approximately 500 m to the east of the Project mining lease application areas.

A comprehensive desktop review was completed to identify the known aquatic ecological values of the waterways and wetlands in the vicinity of the Project area, and to provide context for the field survey results. This included a review of the previous aquatic ecology surveys completed on the site in 2011/2012, and the aquatic ecology surveys for the adjacent Olive Downs Project completed in 2016/2017.

In order to verify and supplement the results of the desktop review, two seasonal aquatic ecology field surveys were completed for this assessment: one in the late-wet season (May 2019) and one in the early-wet season (October 2019). Survey sites included waterways and farm dams, as well as waterways and wetlands outside of the Project area, including the receiving environment of the Isaac River. Survey methods involved aquatic habitat assessments using Australian River Assessment System (AUSRIVAS) protocols, collection of sediment and water quality samples, aquatic plant transect surveys, collection of replicate and AUSRIVAS macroinvertebrate samples (including macrocrustaceans), fish surveys (using a combination of backpack electrofishing, fyke netting, and baited box trapping), turtle surveys (using fyke netting), and platypus habitat assessments.

Stygofauna studies were also completed in May and October 2019, and January 2020. Sampling was completed at eleven bores, including bores within alluvium. Each bore was established at least six months prior to stygofauna sampling and contained groundwater. In-situ water quality measurements for electrical conductivity (EC) and pH were also taken at each bore, to aid in the interpretation of results.

Results

Aquatic habitats in waterways and wetlands in the Study area were typical of ephemeral systems in the broader region, with seasonal patterns in habitat availability and quality. Biological communities (including aquatic plants, macroinvertebrates, macrocrustaceans, fish and turtles) recorded at sites in the Study area and receiving environment were typical of ephemeral systems in central Queensland (Qld). All taxa recorded were common in the broader region, and no listed threatened species known from the catchment (or potential habitat for these species) were identified.

Emergent growth forms dominated aquatic plant communities, with few submerged and floating species, indicating that water is not likely to persist for the majority of the year (except at wetland and farm dam sites). One introduced aquatic plant species was recorded in the vicinity of the Project area: white eclipta (*Eclipta prostrata*); however, this species is considered naturalised across most of Qld.

Macroinvertebrate communities were in low to moderate condition relative to those expected in the broader region, and results indicated that a range of external factors influenced communities at most sites.

Most waterways and wetlands surveyed provided habitat for fish from a range of life-history stages during the wet season, including adults, intermediates and juveniles. One pest species of fish was also recorded in both surveys: mozambique tilapia (*Oreochromis mossambicus*).

Turtles were not particularly abundant or widespread, and were most commonly recorded from farm dams. No potential habitat for the platypus (*Ornithorhynchus anatinus*) was identified.

Overall, aquatic ecosystem values of waterways and wetlands in the Project area and receiving environment were low to moderate, and were considered to be similar to and representative of ephemeral systems in the broader region. Mapped lacustrine and palustrine wetlands and farm dams in the Project area and surrounds varied in their aquatic ecosystem value and were assessed as low to moderate.

The Bureau of Meteorology (BOM) *Groundwater Dependent Ecosystems (GDE) Atlas* provides a model of potential GDEs across Australia based on a national-scale analysis or regional studies. Several aquatic systems within the vicinity of the Project are mapped in the GDE Atlas: the Isaac River and Cherwell Creek are mapped as having high potential for groundwater interaction; wetlands on the Isaac River floodplain and its tributaries are mapped as having high or moderate potential for groundwater interaction; and farm dams mapped as having high or moderate potential for groundwater interaction. The outcomes of this assessment, in conjunction with the outcomes of the Groundwater and Surface Water and Flooding Assessments for the Project, determined that the aquatic in-stream ecosystems associated with the Isaac River and Cherwell Creek are largely not dependent on the surface-expression of groundwater, but would access groundwater for a short period after rainfall events. The wetlands and farm dams in the locality are not likely to be aquatic GDEs.

No aquatic threatened species or communities listed under the EPBC Act or *Nature Conservation Act 1992* (NC Act) (State) were captured or considered likely to occur in the Study area or receiving environment. Two aquatic ecology related MSES were recorded in the Study area, namely, a high ecological significance (HES) wetland and various waterways that provide for fish passage. The HES palustrine wetland, also mapped as a wetland protection area (WPA), is present approximately 5 km downstream of the Project area. This wetland was dry during both field surveys, was assessed as having low value for aquatic fauna, and would rarely be inundated (and therefore would rarely provide aquatic habitat).

Waterways within the Study area are waterways that provide for fish passage, a MSES; specifically, three unnamed tributaries of the Isaac River mapped as low and moderate risk of adverse impacts to fish passage.

No stygofauna specimens were recorded during the surveys, consistent with the results of recent stygofauna sampling conducted for the Olive Downs Project.

Potential Impacts and Mitigation Measures

The Project has the potential to directly influence aquatic ecosystems through clearance and modification of aquatic habitat, specifically removal of three unnamed tributaries of the Isaac River, three State-mapped lacustrine wetlands (that have been ground-truthed as farm dams), four other farm dams within the Project area and one palustrine wetland RE identified during the terrestrial ecology surveys. However, this aquatic ecology assessment demonstrated that the loss of aquatic habitat within the Project area will not have significant impacts to the aquatic ecological values of the region.

Potential indirect impacts to aquatic ecosystems adjacent to and downstream of the Project area could occur as a result of impacts to water quality and / or flows as a result of the Project. However, where the appropriate mitigation and management strategies, such as implementation of an Erosion and Sediment Control Plan, appropriate management of hazardous chemicals and materials, and implementation of water quality monitoring programs during construction and operation of the Project are effectively implemented, the Project is not expected to pose a significant environmental risk on receiving water quality. Further, there is a predicted negligible impact on the water quality or water resources of downstream waterways through the controlled release of mine-affected water from the Project. Additionally, no measurable impacts to surface water quantity are likely to occur as a result of the excision of catchment area associated with the Project.

The majority of the overburden and interburden generated from the Project would generally be expected to have a low sulfur content and be non-acid forming (NAF). Therefore, the risk of impacts to aquatic ecosystems as a result of acid-mine drainage is expected to be low.

The predicted impacts on the Isaac River alluvium groundwater system would be localised and temporary. No impacts to surface aquatic ecosystems, including those mapped as potential surface-expression GDEs as a result of changes in groundwater are predicted. It is considered unlikely that the Project would result in a significant impact to any stygofauna communities (if they were likely to occur).

Considering the existing impacts in the catchment and provided the appropriate mitigation measures are in place, it is considered unlikely that the Project would result in significant cumulative impacts to aquatic ecosystems of the receiving environment of the Isaac River or the Isaac River sub-basin more generally.

Furthermore, implementation of the following management measures would mitigate adverse impacts on aquatic ecology associated with the Project:

- limiting the area of direct impact to aquatic ecosystems to those within the Project area,
- minimising the overall mine footprint by optimising the backfilling of the open cut,
- avoiding clearing of riparian vegetation associated with the Isaac River,
- avoiding creek crossings/waterways for the infrastructure corridor,
- avoiding palustrine wetlands to the north-east of the Project and establishing a 50 m buffer on two of the wetlands,

- ensuring appropriate management plans are developed and implemented for: erosion and sediment control; waste; hydrocarbons and contaminants; and weed and pest animals,
- developing and implementing effective erosion and sediment control strategies that are: designed in accordance with best practice guidelines; designed to contain sediment affected runoff from disturbed areas; and protect against erosion from increased velocities during flood flows (i.e. localised erosion protection works),
- developing and implementing an effective water management system that: minimises the capture of natural flows; effectively manages the storage of mine-affected water as well as clean water; maximises and prioritises use of onsite water retention and recycling; effectively manages acid rock seepage of the mine and achieves water quality objectives (WQOs),
- implementing appropriate water quality monitoring programs as appropriate during the construction phase of the Project, as well as designing and implementing a Receiving Environment Monitoring Program (REMP) during the operational phase,
- implementing a controlled release strategy that ensures release events would coincide with appropriate streamflow conditions in the Isaac River, and
- designing water storage measures (sediment dams and mine water dam) that ensure uncontrolled release events are highly unlikely.

Conclusion

The Project is not expected to have any significant residual impacts on aquatic threatened species and ecological communities listed under the EPBC Act or have a significant impact on a water-dependent ecosystem (such as stygofauna). It is also not expected to have any significant residual impacts on aquatic MSES, including threatened species listed under the NC Act, HES wetlands, or fish passage.

1 Introduction

This aquatic ecology assessment report has been prepared by Ecological Service Professionals (ESP) for Whitehaven WS Pty Ltd (Whitehaven WS), a wholly owned subsidiary of Whitehaven Coal Limited, and forms part of the Environmental Impact Statement (EIS) for the Winchester South Project (the Project).

1.1 Project Background

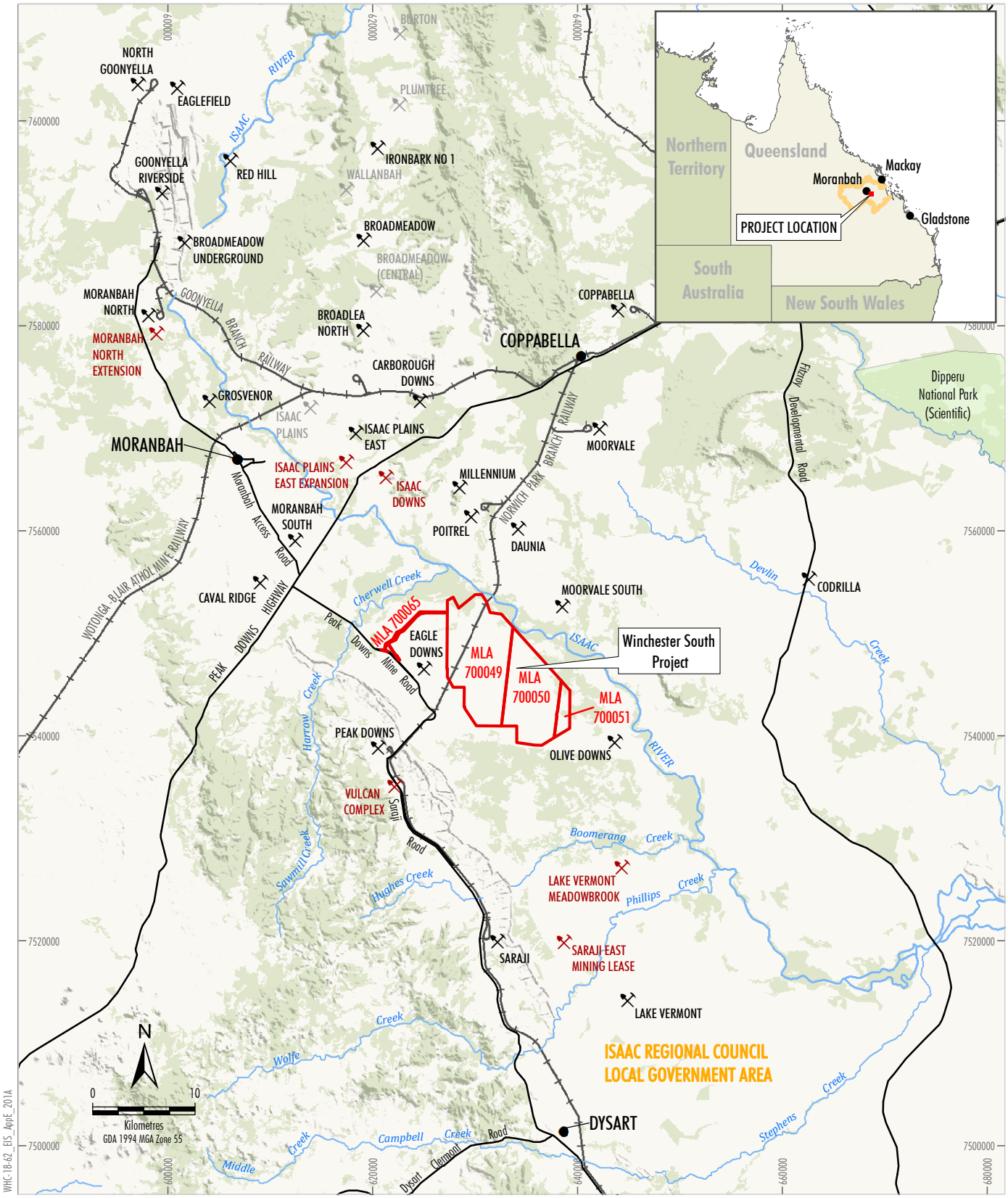
Whitehaven WS proposes to develop the Project, an open cut coal mine and associated infrastructure within the Bowen Basin, located approximately 30 kilometres (km) south-east of Moranbah, within the Isaac Regional Council (IRC) Local Government Area (LGA) (Map 1). The Project involves the development of an open cut coal mine in an existing mining precinct for export of coal products. The Project would include construction and operation of a mine infrastructure area (MIA), including a Coal Handling and Preparation Plan (CHPP), train load-out facility and rail spur, which would be used for the handling, processing and transport of coal. An infrastructure corridor would also form part of the Project, including a raw water supply pipeline connecting to the Eungella pipeline network, an electricity transmission line (ETL) and a mine access road (Map 2, Map 3).

The Project is forecast to extract approximately 15 million tonnes per annum (Mtpa) of run-of-mine (ROM) coal, with a forecast peak extraction of up to 17 Mtpa for approximately 30 years. The coal resource would be mined by open cut mining methods, with product coal to be transported by rail to port for export.

The Project would include, although not to be limited to, the following main components:

- an open cut coal mine which would primarily produce metallurgical coal for steel making (a secondary export quality thermal coal product would also be produced),
- a mine access road from the Eagle Downs Mine Access Road, off Peak Downs Mine Road,
- a new rail loop and train load-out facility connecting to the Norwich Park Branch Railway,
- an ETL from the Eagle Downs Substation to the west,
- a raw water supply pipeline,
- a MIA, including workshops, offices and an on-site CHPP to process ROM coal from the Project, and
- an on-site landfill for the disposal of selected waste streams generated on-site.

The Coordinator-General declared the Project to be a ‘coordinated project for which an EIS is required’ under section 26(1)(a) of the *State Development and Public Works Organisation Act 1971* (SDPWO Act).



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LEGEND

- Mining Lease Application Boundary
- Approved/Operating
- Proposed
- Care and Maintenance
- Local Government Area Boundary
- Railway
- Road

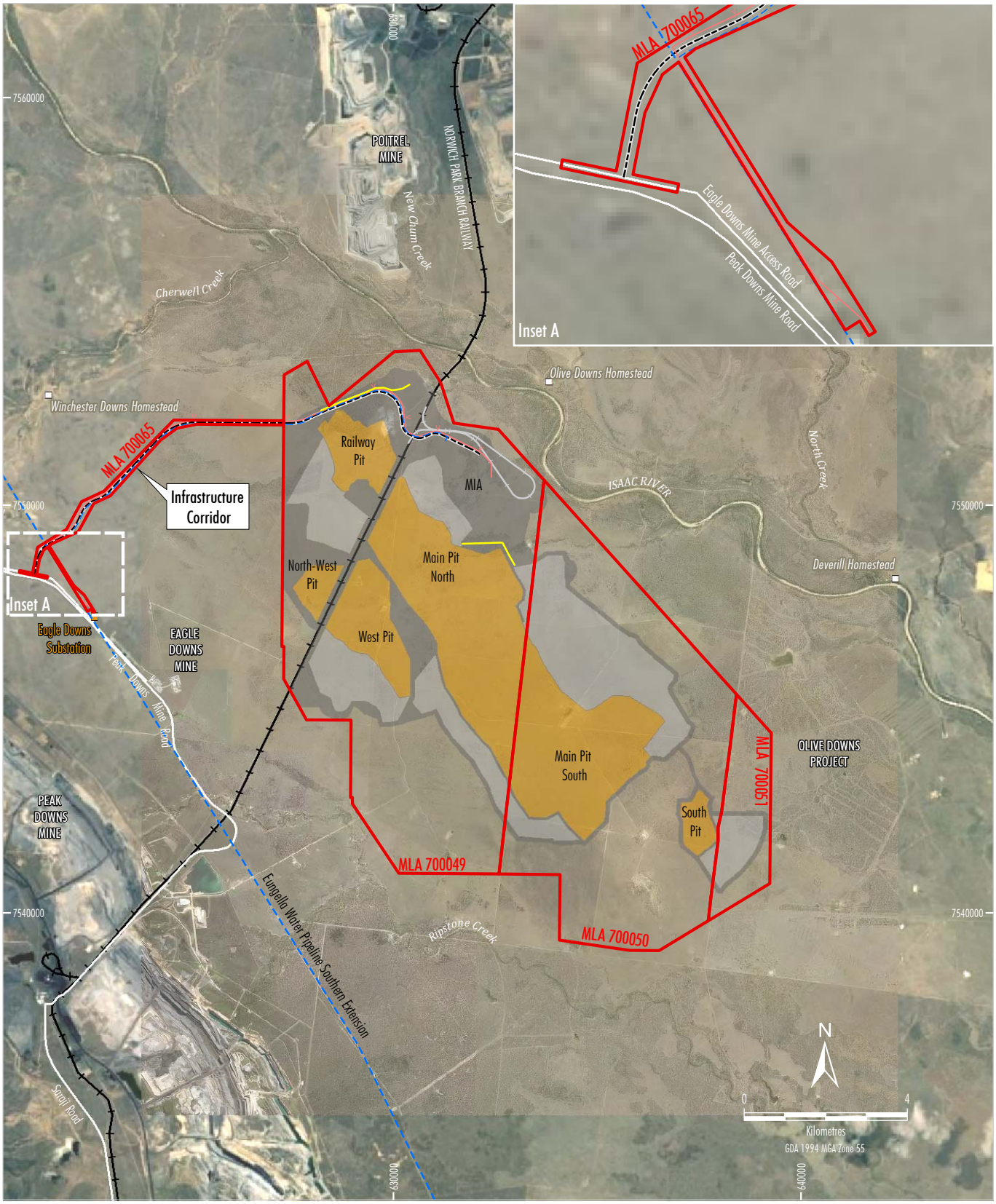
Source: The State of Queensland (2018 - 2020); Geoscience Australia (2018).

WHITEHAVEN COAL

WINCHESTER SOUTH PROJECT

Project Location

Map 1



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LEGEND

- Mining Lease Application Boundary
- Eungella Water Pipeline Southern Extension
- Railway

Project Component*

- Indicative Infrastructure Area
- Indicative Out-of-pit Waste Rock Emplacement
- Indicative Open Cut Pit Including In-pit Waste Rock Emplacement
- Indicative Mine Access Road
- Indicative Rail Spur and Loop
- Indicative Electricity Transmission Line
- Indicative Raw Water Supply Pipeline
- Indicative Flood Levee

*Notes: * Excludes some project components such as water management infrastructure, access tracks, topsoil stockpiles, explosives magazines, power reticulation, temporary offices, other ancillary works and construction disturbance.*

Source: The State of Queensland (2018 - 2020); Whitehaven (2020). Orthophoto: Google Image (2019); Whitehaven (2017).

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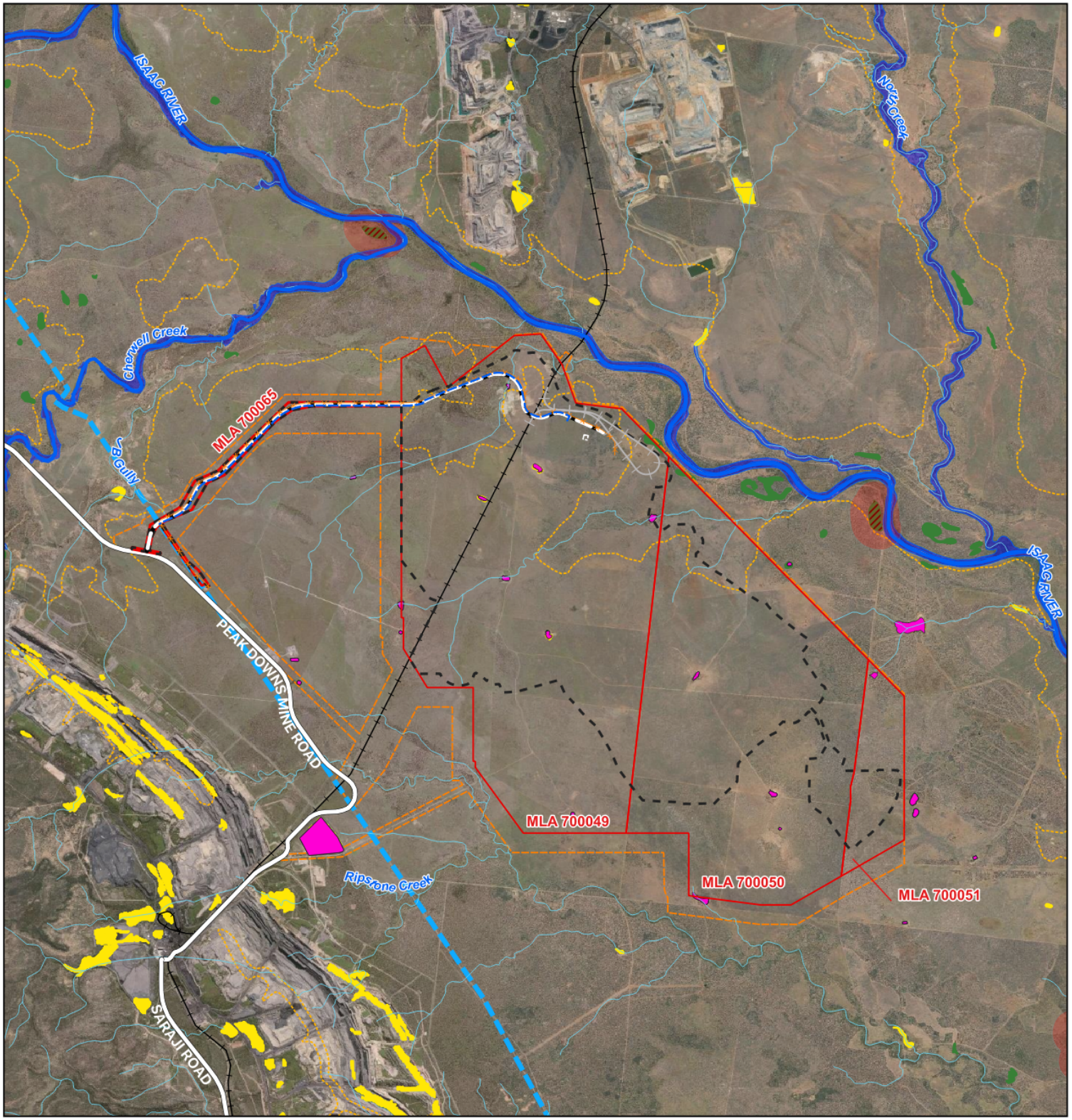
WINCHESTER SOUTH PROJECT

Project General Arrangement

Map 2



Legend

- Indicative raw water supply pipeline
- Indicative mine access road
- Indicative electricity transmission line
- Indicative rail spur loop
- Indicative surface disturbance extent
- Winchester South MLA
- Eungella pipeline
- Primary study area
- Road
- Railway
- Dam**
- Queensland floodplain assessment overlay

Waterways and Wetlands*

- Waterway - major
- Waterway - minor
- Riverine wetland
- Lacustrine wetland
- Palustrine wetland
- MSES HES wetland
- WPA trigger area

*as per Government mapping and not ground-truthed
**note farm dams were ground-truthed from surveys conducted in May and October 2019

Map 3: Winchester South Project key infrastructure components and Qld State Government mapped waterways and wetlands in the vicinity of the Project

Project Number: 1845
Author: JK
Date: 02 November 2020
Datum: GDA94
Data Sources:
© DES 2020; DNRME 2020; DTMR 2020; Esri 2020; E2M 2020

0 1 2 3 4 km

Three referrals have been made under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) regarding the three different components of the Project. A delegate of the Commonwealth Minister for the Environment (the Commonwealth Minister) determined the following controlling provisions apply for each action under the EPBC Act:

1. Winchester South Project Mine Site and Access Road (EPBC 2019/8460)
    a. listed threatened species and communities (sections 18 and 18A), and
    b. a water resource, in relation to coal seam gas development and large coal mining development (sections 24D and 24E).
2. Winchester South Project Water Pipeline (EPBC 2019/8459)
    a. listed threatened species and communities (sections 18 and 18A).
3. Winchester South Project Electricity Transmission Line (EPBC 2019/8458)
    a. listed threatened species and communities (sections 18 and 18A).

The EIS process under Part 4 of the SDPWO Act has been accredited under the Bilateral Agreement for the assessment of the Project under the EPBC Act. The EIS therefore addresses both the *Environmental Protection Act 1994* (EP Act) (State) and EPBC Act (Commonwealth) matters, in accordance with the Terms of Reference (TOR) for the EIS, which was issued in September 2019.

1.2 Scope of the Assessment

This report documents the current condition of the aquatic ecosystems in the vicinity of the Project and provides an assessment of the potential impacts of the Project on aquatic ecology. Specifically, it provides:

- a summary of aquatic flora and fauna (including aquatic macroinvertebrates, fish, reptiles and mammals) known from, likely, or predicted to occur in the vicinity of the Project, as informed by the desktop review and results from comprehensive seasonal surveys,
- a detailed assessment of aquatic ecological condition of waterways, wetlands and potential surface-expression groundwater dependent ecosystems (GDEs) in the vicinity of the Project,
- an assessment of the potential presence of a stygofauna community in the groundwater aquifer, as informed by the desktop review and results from a pilot study,
- an assessment of the potential likelihood of occurrence of any Matters of National Environmental Significance (MNES) and Matters of State Environmental Significance (MSES), including results from targeted surveys,
- an assessment of the potential indirect, direct and cumulative impacts of the Project on aquatic ecology (including threatened species and communities) and stygofauna,
- a summary of avoidance and mitigation measure to minimise impacts, and

- an assessment of any residual significant impacts associated with the Project in accordance with the *Matters of National Environmental Significance: Significant Impact Guidelines 1.1* (Department of the Environment [DotE] 2013a), *Significant Impact Guidelines 1.3: Coal Seam Gas and Large Coal Mining Developments – Impacts on Water Resources* (DotE 2013b) and the *Queensland Environmental Offsets Policy – Significant Residual Impact Guideline* (Department of Environment and Heritage Protection [EHP] 2014).

1.3 Terms of Reference

The TOR for the Project, released on 4 September 2019, describe the matters that Whitehaven WS are to address in the EIS. Table 1.1 addressed the TOR relevant to aquatic ecological values in this report.

Table 1.1 Terms of Reference specific to aquatic ecological values

TOR Number	Terms of Reference	Relevant Section
Flora and fauna		
	Objectives Biodiversity including matters of state environmental significance are identified and appropriately safeguarded to support healthy and resilient ecosystems and ensure the sustainable, long-term conservation of biodiversity and the social, economic, cultural and environmental benefits it provides.	**3, 4, 5, 6**
Existing environment		
11.16	Identify and describe MSES, state and regionally significant biodiversity and natural environmental values of the terrestrial and aquatic ecology likely to be impacted by the project, including watercourses impacted by groundwater drawdown or diversion; Isaac River floodplain ecology (especially as it relates to changes from levees and groundwater drawdown impacts); groundwater-dependent ecosystems and high ecological significance wetlands. Where MSES have been addressed in the section on MNES, cross referencing may be appropriate.	1.4.4, 1.4.5, 3.1, 3.4, 3.7, 3.8, 3.9, 5.1 to 5.14, 5.16, 6.9
Impact assessment		
11.17	Describe the potential direct and indirect impacts on the biodiversity and natural environmental values of affected areas such as breeding, roosting, nesting and foraging habitat, arising from the construction, operation and eventual decommissioning of the project (including potential/likely and known impacts) in accordance with DES EIS information guidelines (see Appendix 1).	5.1, 5.2, 5.5, 5.6, 5.16, 6.9, 8
11.18	Assess the need for buffer zones and the retention, rehabilitation or planting of movement corridors. Detail measures that would avoid the need for waterway barriers or measures to mitigate the impacts of their construction and operation where unavoidable.	5.2, 6.1, 6.2
11.19	Describe how the achievement of the rehabilitation objectives would be monitored and audited, and how corrective actions would be managed.	Rehabilitation of disturbed areas is discussed elsewhere; refer to EIS Main Text

TOR Number	Terms of Reference	Relevant Section
11.20	Taking into account all proposed avoidance and/or mitigation measures. The assessment should include, but not be limited to, the following key elements:	
	(a) MSES	5.16, 6.9
	(b) terrestrial and aquatic ecosystems (including groundwater-dependent ecosystems) and their interaction	5.1, 5.2, 5.7, 5.12, 5.16, 6.1, 6.2, 6.6, 6.9
	(c) biological diversity including listed flora and fauna species and regional ecosystems	5.1, 5.11, 5.16, 6.6
	(d) the existing integrity and connectivity of ecological processes and ecosystems, including habitats of threatened, near-threatened or special least-concern species	5.1, 5.2, 5.7, 6.1, 6.2
	(e) the integrity of landscapes and places, including wilderness and similar natural places	5.1, 5.9, 5.16, 6.1, 6.2
	(f) actions of the project that require an authority under the *Nature Conservation Act 1992,* and/or would be assessable development for the purposes of the *Vegetation Management Act 1999*[6]	3.7, 5.1, 5.16
	(g) chronic, low-level exposure to contaminants or the bio-accumulation of contaminants	5.3, 5.4, 5.5, 5.6, 5.8, 5.10, 6.3, 6.4, 6.6, 6.7
	(h) impacts on native fauna due to wastes on the site, particularly those related to any form of toxicants in supernatant water of any tailings storage facility.	5.3, 5.4, 5.5, 5.6, 5.8, 5.10, 6.3, 6.4, 6.6, 6.7
11.21	Include maps at suitable scales showing the location of disturbance areas, estimates of disturbance for MSES likely to be impacted as a result of the project, and quantify the extent of habitat for listed threatened species and communities adjacent to the project site to provide clarity on the regional context of these habitats on the project site. Where MSES have been addressed in the section on MNES, cross referencing may be appropriate.	1.4.4, 3.1.2, 3.1.2.1, 3.4, 3.7, 3.9, 5.1, 5.16
11.22	Describe the cumulative impacts of the proposed project, in conjunction with existing development and possible future development (as described by approved plans and existing project approvals), to ecosystem resilience, flora and fauna and impacts to the Isaac River floodplain ecology.	5.14
Mitigation measures		
11.23	Describe how the achievement of the flora and fauna objectives would be monitored, audited and reported, and how corrective/preventative actions would be managed for all phases of the project.	6.6, 6.7
11.24	Propose practical measures for protecting or enhancing natural values and assess how the nominated quantitative indicators and standards are to be achieved for nature conservation management. In particular, address measures to protect or preserve any threatened or near-threatened species.	5.16, 6.2, 6.9
11.25	The measures proposed for the progressive rehabilitation of disturbed areas should include rehabilitation success criteria in relation to natural values that would be used to measure the progress and adjust practices if necessary to ensure success over time.	Progressive rehabilitation of terrestrial areas is discussed elsewhere; refer to EIS Main Text

[6] This is notwithstanding that the *Vegetation Management Act 1999* does not apply to mining projects on resource tenements. Refer also to https://www.qld.gov.au/environment/land/management/vegetation/exemptions

TOR Number	Terms of Reference	Relevant Section
11.26	Proposals for the rehabilitation of disturbed areas should incorporate, where appropriate, provision of nest hollows, watering points and ground litter.	Progressive rehabilitation of terrestrial areas is discussed elsewhere; refer to EIS Main Text
Offsets		
11.27	The EIS should identify whether the project will result in a significant residual impact on MSES with reference to the Queensland Environmental Offsets Policy, Significant Residual Impact Guideline 2014. The EIS should reference relevant parts of the Guide to determining terrestrial habitat quality (see Appendix 1) and must demonstrate that offsetting is the preferred option after all avoidance and mitigation measures have been considered, in accordance with the *Environmental Offsets Act 2014*.	3.9, 5.16, 7
11.28	Identify and illustrate the extent of any overlap between MNES and MSES.	5.15, 5.16
11.29	For any significant residual impact, propose offsets that are consistent with the following requirements as set out in applicable State and Commonwealth legislation or policies:	
	(a) where a significant residual impact will occur on a prescribed environmental matter as outlined in the Environmental Offsets Regulation 2014, the offset proposal(s) must be consistent with the requirements of Queensland's *Environmental Offsets Act 2014* and the latest version of the Queensland Environmental Offsets Policy (Version 1.6) 2018 (see Appendix 1)	7
	(b) where Commonwealth offset policy requires an offset for significant residual impacts on a MNES, the offset proposal(s) must be consistent with the requirements of the EPBC Act Environmental Offsets Policy (October 2012), the Offsets assessment guide and relevant guidelines.	7
11.30	For staged offsets, the full extent of potential impacts on prescribed environmental matters from the entire proposal needs to be taken into account as part of the significant residual impact test.	7
Biosecurity		
	Objective The construction and operation of the project should aim to ensure:	
	(a) the spread of weeds, pest animals and vector agents are minimised	6.6
	(b) existing weeds and pests are controlled.	6.6
Existing environment		
11.31	Detail any known issues with weeds, pest and vector agents within the project area.	3.4.1, 3.6.1.1
Impact assessment		
11.32	Detail the potential impacts of project operations on the spread of weeds, pest and vector agents within and adjacent to the project area	5.11
Mitigation measures		
11.33	Propose detailed measures to control and limit the spread of restricted matters including noxious fish, invasive plants and invasive animals on the project site and adjacent areas as per Schedule 2 of the Biosecurity Regulation 2016, and any relevant local government area Biosecurity Plans.	5.11, 6.6

TOR Number	Terms of Reference	Relevant Section
11.34	Provide information relating to the distribution and abundance of invasive plants which are considered to be weeds of national significance (WoNS) on the project sites.	3.4.1
11.35	Provide details of any proposed vertebrate pest and weed control programs to be implemented by the project.	6.6
Matters of national environmental significance (MNES)		
Background and context		
11.141	On 13 May 2019, the proponent referred the project as three separate proposed actions for a 'controlled action' decision under the EPBC Act (EPBC 2019/8460 Mine Site and Access Road; EPBC 2019/8459 Water Pipeline; EPBC 2019/8458 Electricity Transmission Line). It is expected that the EIS will relate to all three proposed actions.	1.1, 5.15
11.142	The Commonwealth Minister for the Environment may determine that the project will have or is likely to have a significant impact upon the following matters of national environmental significance under the EPBC Act:	1.1, 5.15
	(a) For the Winchester South Project Mine Site and Access Road (EPBC 2019/8460):	5.15.1
	• listed threatened species and communities (sections 18 and 18A)	
	• a water resource, in relation to coal seam gas and large coal mining (sections 24D and 24E).	
	(b) For the Winchester South Water Pipeline (EPBC 2019/8459):	5.15.2
	• listed threatened species and communities (sections 18 and 18A).	
	(c) Winchester South Project Electricity Transmission Line (EPBC 2019/8458):	5.15.3
	• listed threatened species and communities (sections 18 and 18A).	
11.143	The EIS is to be prepared pursuant to the Bilateral Agreement. It must meet the impact assessment requirements under both Commonwealth and Queensland legislation. The projects will require approval from the responsible Commonwealth minister under Part 9 of the EPBC Act before they can proceed.	1.1
11.144 to 11.149		Refer to EIS Main Text
11.150	In accordance with the Bilateral Agreement, the EIS must:	
	(a) assess all relevant impacts that each proposed action has, will have or is likely to have;	5.15
	(b) provide enough information on each proposed action and its relevant impacts to allow the Commonwealth Minister for the Environment to make an informed decision whether or not to approve the action under Part 9 of the EPBC Act; and	5.15
	(c) address the matters mentioned in Division 5.2 of the Environment Protection and Biodiversity Conservation Regulations 2000 (Cth) (EPBC Regulations).	Refer to EIS Main Text
11.151	A cross-reference to the relevant sections in the MNES chapter that addresses each of the matters mentioned in Division 5.2 of the EPBC Regulations should be provided.	Refer to EIS Main Text

TOR Number	Terms of Reference	Relevant Section
11.152	Consideration is to be given to any relevant information, policy statements and guidelines (available at **www.environment.gov.au**) including but not limited to:	
	(a) Significant impact guidelines 1.1 - Matters of National Environmental Significance (see Appendix 1)	5.15
	(b) Significant impact guidelines 1.3 - coal seam gas and large coal mining developments – impacts on water resources (see Appendix 1)	5.15.1
	(c) *Environment Protection and Biodiversity Conservation Act 1999*	3.10, 5.15
	(d) EPBC Act Environmental Offsets Policy (see Appendix 1)	7
	(e) Species Profile and Threats (SPRAT) Database; and	3.6, 3.7, 3.10, Appendix A
	(f) any approved conservation advices, recovery plans and threat abatement plans (as relevant) for listed threatened species and ecological communities.	3.7
11.153	The proposed mine and access road (EPBC 2019/8460), the proposed water pipeline (EPBC 2019/8459) and the proposed electricity and transmission line (EPBC 2019/8458) should each initially be assessed in their own right. How each proposed action relates to the other proposed actions should also be addressed.	5.15.1, 5.15.2, 5.15.3
11.154	Predictions of the extent of threat (risk), impact and the benefits of any avoidance, mitigation and management measures proposed, must be scientifically robust, supported by relevant suitably qualified experts and/or supported by technical data. Reference all sources of information relied upon and provide an estimate of the reliability of predictions.	5.15, 6.8, 9, Appendices A to E
11.155	Any positive impacts on relevant MNES may be identified and evaluated.	6.1, 6.2, 6.8
11.156	The MNES chapter should describe any additional new field work, modelling or testing that, when used in conjunction with existing information, provides sufficient confidence in predictions so that well-informed decisions can be made. The extent of any new field work, modelling or testing should be commensurate with risk.	2, 3, 4
Assessment requirements		
11.157 to 11.160		Refer to EIS Main Text
Listed threatened species and communities (sections 18 and 18A)		
Existing Environment		
11.161	The MNES chapter must describe the relevant listed threatened species and ecological communities (including EPBC Act listing status, distribution, life history and habitat).	3.6.1, 3.6.2, 3.7.1, 3.7.2, 3.10
11.162	Provide details of the scope, methodology, timing and effort of surveys for each proposed action (including areas outside of each proposed action area which may be impacted by each proposed action), and include details of:	1.2, 2.1, 2.1.2, 2.1.2.1, 2.1.2.2, 2.1.2.6, 2.1.2.8
	(a) the application of best practice survey guidelines;	2.1.2.8
	(b) how studies or surveys are consistent with (or a justification for divergence from) published Australian Government guidelines and policy statements.	2.1.2.8
11.163	The MNES chapter must include records identified from field surveys of the below listed threatened species and ecological communities within and/or adjacent to the project site for each proposed action. The records must include a description of the habitat in which the record was identified.	3.7, 3.10.1

TOR Number	Terms of Reference	Relevant Section
11.164	The MNES chapter must include known historical records of the below listed threatened species and ecological communities in the broader region. All known records must include the source (i.e. Commonwealth and State databases, published research, publicly available survey reports, etc.), the year of the record and a description of the habitat in which the record was identified.	Not relevant to aquatic ecology; refer to Terrestrial Ecology Assessment and EIS Main Text
11.165	The MNES chapter must include a detailed habitat assessment for each of the below listed threatened species and ecological communities within the project site of each proposed action. The habitat assessments must:	3.7, 3.10.1
	(a) consider habitat use requirements (e.g. denning, foraging, breeding, nesting, dispersal, etc.);	3.7
	(b) be informed by desktop analysis and field surveys;	2.1.1, 2.1.2
	(c) be in accordance with a departmental, state or local government habitat quality assessment methodology, and be included in an appendix to the EIS, along with the justification for using the chosen methodology;	2.1.2.3, 2.1.2.8
	(d) consider relevant departmental documents (e.g. approved conservation advices, recovery plans, draft referral guidelines and listing advices), the SPRAT Database; and	3.7
	(e) be supported by relevant published research (if required).	3.7, 9
11.166	The MNES chapter must include the area (in hectares) and quality of all suitable habitats within each proposed action.	3.7, 3.10, 5.15
11.167	The MNES chapter must include detailed mapping of suitable habitat for the below listed threatened species and ecological communities within each proposed action, which must:	3.7, 3.10.1, 5.15
	(a) be specific to the habitat assessment undertaken for each listed threatened species and ecological community (Note: provision of Queensland Regional Ecosystems alone is not adequate);	
	(b) include an overlay of the disturbance footprint;	
	(c) include known records of individuals from desktop analysis and/or field surveys; and	
	(d) be provided separately as attachments in a JPEG format.	
Impact assessment		
11.168	For each proposed action, describe and assess the impacts (direct, indirect and consequently) to each listed threatened species and ecological community identified below, and any other that are found to be or may potentially be present in areas that may be impacted by any stages of each proposed action in accordance with the Significant impact guidelines 1.1 – Matters of National Environmental Significance (see Appendix 1).	5.5, 5.6, 5.10, 5.11, 5.15
11.169	Identify which aspect of each proposed action is of relevance to each listed threatened species or ecological community or if the threat of impact relates to consequential actions.	5.15
11.170	The MNES chapter must identify and address cumulative impacts, where potential project impacts are in addition to existing impacts of other activities (including known potential future projects by the proponent and/or other proponents in the region and vicinity).	5.14
11.171	The impacts must be assessed in accordance with relevant departmental policies and guidelines, and information provided in the SPRAT Database. Any technical data and other information used or needed to make a detailed assessment of the relevant impacts must be included as appendices to the EIS.	This report

TOR Number	Terms of Reference	Relevant Section
11.172	Where relevant, the MNES chapter is to demonstrate that each proposed action will have regard to any approved conservation advice.	3.7
11.73	Where relevant, the EIS is to demonstrate that each proposed action will not be inconsistent with: (a) Australia's obligations under: iv. the Biodiversity Convention; v. the Convention on the Conservation of Nature in the South Pacific (Apia Convention); (b) any relevant recovery plans or threat abatement plans.	Not relevant to aquatic ecology; refer to Terrestrial Ecology Assessment and EIS Main Text
Mitigation measures		
11.174	The MNES chapter must include detailed descriptions of measures proposed to be undertaken by the proponent to avoid, mitigate and manage relevant impacts of all stages of each proposed action on listed threatened species and communities. The proposed measures should be based on best available practices, appropriate standards and supported by scientific evidence. The MNES chapter must include: (a) proposed measures to be undertaken to avoid and mitigate the relevant impacts of each proposed action on listed threatened species and communities, including those required by other Commonwealth, State and local government approvals; (b) an assessment of the predicted effectiveness of the proposed measures; (c) any statutory or policy basis for the proposed measures, including reference to the SPRAT Database and relevant approved conservation advices, and a discussion on whether the proposed measures are not inconsistent with relevant recovery plans and threat abatement plans; (d) details of ongoing management, including monitoring programs to support an adaptive management approach and determine the effectiveness of the proposed measures; (e) details on measures, if any, proposed to be undertaken by State and local government, including the name of the agency responsible for approving each measure; and (f) information on the timing, frequency and duration of the measures to be implemented.	6
11.175	All proposed measures should consider the 'S.M.A.R.T' principle: (a) S – Specific (what and how); (b) M – Measurable (baseline information, number/value, auditable); (c) A – Achievable (timeframe, money, personnel); (d) R – Relevant (conservation advices, recovery plans, threat abatement plans, scientific evidence); and (e) T – Time-bound (specific timeframe to complete).	6
11.176	An outline of an Environmental Management Plan (EMP) that sets out the framework for management, mitigation and monitoring of relevant impacts of the proposed actions, including any provisions for independent environmental auditing, may be included as an appendix to the EIS.	Refer to EIS Main Text

TOR Number	Terms of Reference	Relevant Section
List of potential listed threatened species		
11.177	The MNES chapter is to address impacts on, but not limited to, the following listed threatened species for each proposed action:	
	Fish	
	(a) Murray Cod (*Maccullochella peelii*) – vulnerable;	3.7.1, 3.10.1, 5.15
	Reptile	
	(a) Southern Snapping Turtle (*Elseya albagula*) – critically endangered; (b) Fitzroy River Turtle (*Rheodytes leukops*) – vulnerable;	3.7.2, 3.10.1, 5.15
List of potential listed threatened ecological communities		
11.178	The EIS is to address the impacts on, but not limited to, the following listed threatened ecological communities for each proposed action:	Refer to EIS Main Text
	(a) Brigalow (*Acacia harpophylla* dominant and co-dominant) – endangered; and	
	(b) Natural Grasslands of the Queensland Central Highlands and northern Fitzroy Basin - endangered.	
	(c) Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions – endangered.	
A water resource, in relation to coal seam gas development and large coal mining development		
11.179	The National Partnership Agreement on Coal Seam Gas and Large Coal Mining, to which Queensland is a signatory, specifies that all coal seam gas and large coal mining proposals that are likely to have a significant impact on water resources are to be referred to the Independent Expert Scientific Committee (IESC) for advice.	Noted
11.180	In relation to the proposed mine and access road (EPBC 2019/8460), the MNES chapter must provide details on the use and interference with the current state of groundwater and surface water in the region as well as any use of these resources.	5.15.1
11.181	The MNES chapter is to describe and assess the impacts to water resources giving consideration to the Significant Impact Guidelines 1.3: Coal seam gas and large coal mining developments – impacts on water resources (see Appendix 1).	5.15.1
11.182	The MNES chapter is to address the information requirements contained in the Information guidelines for proponents preparing coal seam gas and large coal mining development proposals and provide a cross-reference table to identify where each component of the guidelines has been addressed (see Appendix 1). Explanatory notes on the IESC information guidelines may assist in addressing the information requirements:	
	(a) Information Guidelines explanatory note - Uncertainty analysis–Guidance for groundwater modelling within a risk management framework;	Not directly relevant to aquatic ecology; refer to EIS Main Text
	(b) Information Guidelines explanatory note - Assessing groundwater-dependent ecosystems; and	2.1.2.1, 2.2, 3.8, 4
	(c) Information Guidelines explanatory note - Deriving site-specific guideline values for physico-chemical parameters and toxicants.	2.1.2.4, 2.1.2.5

TOR Number	Terms of Reference	Relevant Section
Offsets		
11.183	For each of the proposed actions the MNES chapter must include an assessment of the likelihood of residual significant impacts occurring on listed threatened species and communities after avoidance, mitigation and management measures relating to the projects have been applied. If it is determined that a residual significant impact is likely, include a draft Offset Management Strategy (as an appendix to the EIS) that provides, at a minimum:	7
	(a) details of the environmental offset/s (in hectares) for residual significant impacts of the proposed action on relevant MNES, and/or their habitat;	Not directly relevant to aquatic ecology (no significant impact predicted); refer to EIS Main Text
	(b) details of how the environmental offset/s meets the requirements of the Department's EPBC Act Environmental Offsets Policy (2012) (EPBC Act Offset Policy), including the Offsets Assessments Guide, available at: **www.environment.gov.au/epbc/publications/epbc-act-environmental-offsets-policy**;	
	(c) details of a strategy for the staging of environmental offset/s for each project stage (if proposed);	
	(d) details of appropriate offset area/s (including a map) to compensate for the residual significant impact on relevant MNES, and/or their habitat;	
	(e) information about how the proposed offset/s area provides connectivity with other relevant habitats and biodiversity corridors; and	
	(f) details of the mechanism to legally secure the environmental offset/s (under Queensland legislation or equivalent) to provide protection for the offset area/s against development incompatible with conservation.	

1.4 Description of the Study Area

The Project area comprises the open cut extent, waste rock emplacement areas and associated infrastructure areas, including the infrastructure corridor. The Study area for the Project includes waterways, farm dams and wetlands upstream of, adjacent to, within, and downstream of (i.e. the receiving environment of) the Project, including the Isaac River and its tributaries (including Cherwell Creek), and Ripstone Creek and its tributaries (Map 3).

1.4.1 Regional Setting

The Study area is located within the Bowen Basin in the Fitzroy Basin Association natural resource management region of central Qld. The Study area lies within the IRC LGA, approximately 30 km south-east of Moranbah and 50 km north of Dysart. The nearest City is Mackay, which is approximately 200 km north-east of the Study area (Map 4).

1.4.2 Rainfall

Average annual rainfall in the vicinity of the Project is approximately 563 millimetres (mm). The wettest period is typically during the warmer months from December to March, when approximately 65% of the annual rainfall occurs on average (Figure 1.1; Bureau of Meteorology [BOM] 2019a). Rainfall is typically lowest during autumn and winter.

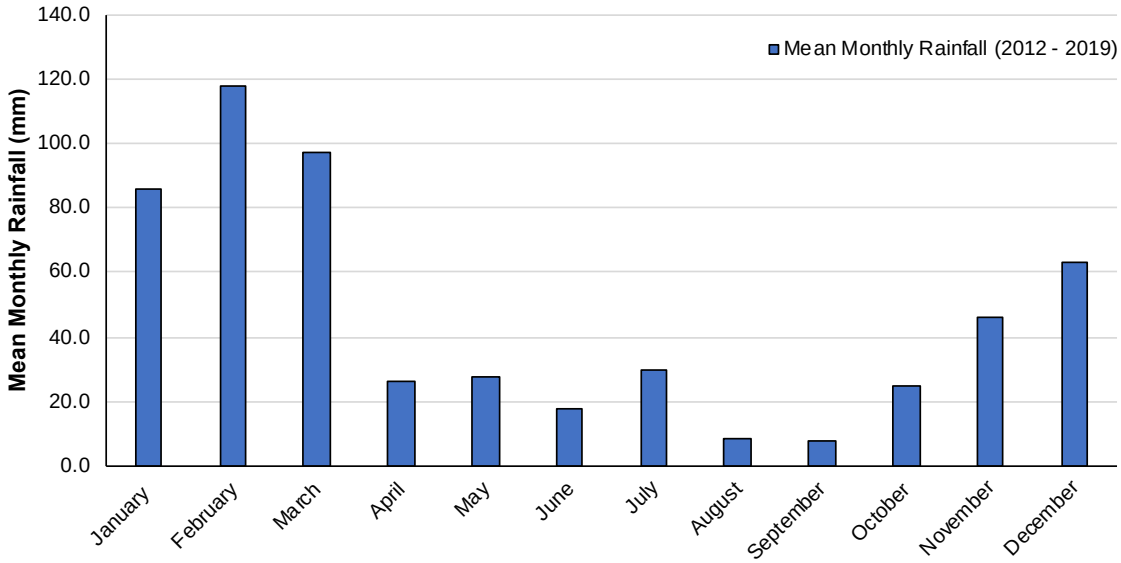


Figure 1.1 Mean monthly rainfall statistics from BOM station 035039 (2012 – 2019)

1.4.3 Topography

The Study area lies on a landscape characterised by flat to gently undulating plains. Its elevation ranges from approximately 185 meters (m) Australian Height Datum (AHD) to 235 m AHD.

The surrounding landscape is also relatively flat to undulating and includes a cluster of mountains to the east which range from 471 m AHD (Mount Coxendean) to 310 m AHD (Iffley Mountain). Possum Hill and Red Hill (both 330 m AHD) lie to the west and north of the Study area, respectively. The Cherwell and Harrow Ranges lie even further to the west and range from approximately 300 m AHD to 500 m AHD.

1.4.4 Waterways and Wetlands

Natural waterways in the region are typically temporary or ephemeral streams, which are dry for most of the year and flow for a short time following rainfall events that are more common in the wet season. There are several waterways within the Study area. These include (Map 3):

- the Isaac River, which flows from the north in a south-easterly direction, adjacent to the Project area,
- several unnamed waterways that are tributaries to the Isaac River, namely:
    - A northern unnamed waterway and its associated tributaries, the headwaters of which are crossed by the water pipeline, ETL and access road, and the downstream reach of which flows through mining lease application (MLA) 700049.
    - A central unnamed waterway and its associated tributaries, the headwaters of which flow through MLA 700049 and the downstream reach and downstream tributary which flow through MLA 700050.
    - A southern unnamed waterway and its associated tributaries, the headwaters of which originate just within MLA 700050 and MLA 700051.
- Ripstone Creek (and associated tributaries), which flows from the west, adjacent to the southern portion of the Project area, and into the Isaac River, and
- Cherwell Creek located to the north-west of the Project area.

In addition to waterways, several wetlands are located within the Study area (Map 3) including:

- mapped lacustrine wetlands, which are actually farm dams,
- farm dams that are unmapped but considered to provide aquatic habitat,
- mapped palustrine wetlands, including two immediately downstream of the north-eastern boundary of the Project area and a palustrine wetland RE identified during terrestrial ecology surveys, and
- one wetland of High Ecological Significance (HES) located approximately 4 km east (5 km downstream) of the Project area, and several other HES wetlands along the Isaac River floodplain within 20 km downstream. These wetlands are identified under the *Environmental Protection (Water and Wetland Biodiversity) Policy 2019* (EPP [Water and Wetland Biodiversity]); and are also designated as wetland protection areas (WPAs) in Great Barrier Reef catchments, and are MSES protected under the EP Act.

The Study area is within the Isaac River sub-basin, which is part of the wider Fitzroy River Basin (Map 4). The Isaac River sub-basin covers an area of approximately 22,364 square kilometres (km^2). The Isaac River originates north of Moranbah in the Great Dividing Range and flows in a south-easterly direction, flowing adjacent to the Project area and eventually discharging into the Mackenzie River approximately 150 km downstream of the Project. Ultimately, the Mackenzie River joins the Fitzroy River, which flows initially north and then east towards the east coast of Qld, discharging into the Coral Sea south-east of Rockhampton approximately 315 km downstream of Study area (Map 4). The waters of the Isaac River sub-basin are included in Schedule 1 of the (EPP [Water and Wetland Biodiversity]). Under this document, the waters of the Project area and receiving environment are classified as within the Isaac and lower Connors River main channel and Isaac western upland tributaries sub-catchments (EHP 2011; Map 4).

No wetlands of national or international significance occur within 30 km of the Project area (Department of Agriculture, Water and the Environment [DAWE] 2020a). The Fitzroy River ultimately discharges into the Great Barrier Reef World Heritage Area (GBRWHA) and Marine Park (GBRMP) (Map 4), both protected MNES under the EPBC Act. However, the GBRWHA and GBRMP are remote from the activities of the Project, are not controlling provisions for this Project, and as such are not considered further.

There are no fish habitat areas protected under the *Fisheries Act 1994* in the Project area.

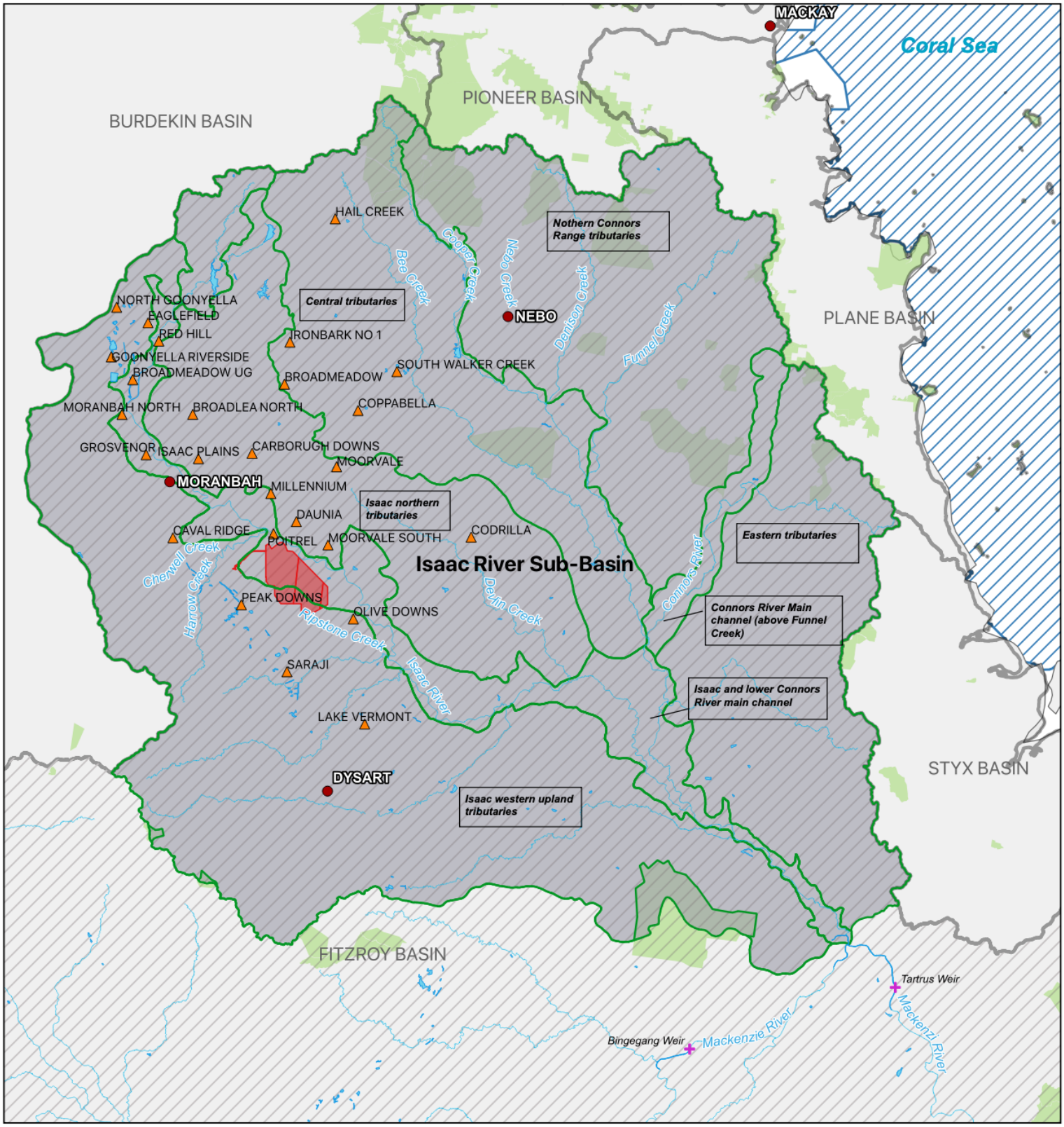
1.4.5 Groundwater

The hydrogeological regime relevant to the Project comprises the following hydrogeological units (SLR Consulting Australia Pty Ltd [SLR] 2021):

- Cainozoic sediments:
    - Quaternary alluvium – unconfined aquifer (water-bearing strata of permeable rock, sand, or gravel) localised along Isaac River,
    - Quaternary to Tertiary colluvium and weathered units (regolith) – unconfined and largely unsaturated unit bordering alluvium, and
    - Triassic Rewan Group – aquitard overlying Permian coal measures,
- Permian coal measures with:
    - Low permeability interburden units with aquitard properties, and
    - Coal sequences that exhibit water bearing properties associated with secondary porosity through cracks and fissures.

Alluvial groundwater elevations range from around 179 m AHD at the northern end of the Project area, and between approximately 162 m AHD to 166 m AHD to the south-east, increasing with proximity to the Isaac River (i.e. losing stream conditions) (SLR 2021).

Overall, the regolith is considered to be largely unsaturated, with the presence of water restricted to lower elevation areas along the Isaac River and the lower reaches of its tributaries (i.e. Ripstone Creek). Flow within the regolith where it is saturated is a reflection of topography, flowing towards nearby drainage lines (SLR 2021). The Rewan Group comprises low hydraulic conductivity lithologies and is typically considered an aquitard (SLR 2021).



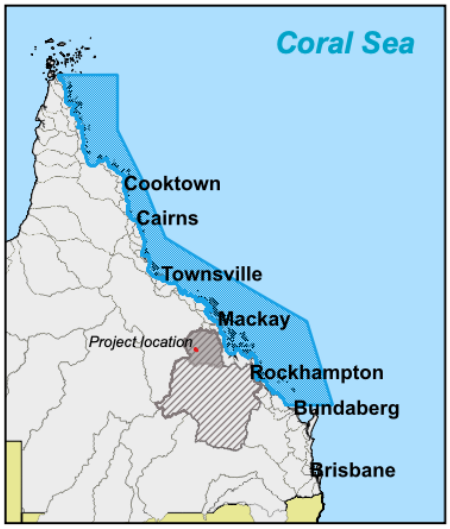
Legend

- Town
- Mine
- Dam, weir or barrage
- Winchester South MLA
- Waterway
- Lake or reservoir
- Protected area
- Great Barrier Reef Marine Park
- Fitzroy River Drainage Basin
- Drainage Basin (other)
- Isaac River Sub-basin
- EPP Sub-catchment

Map 4: Regional context

Project Number: 1845
Author: JK
Date: 12 October 2020
Datum: GDA94
Data Sources:

0 20 40 60 km



The water levels in the coal measures within the Project area generally follow the downstream flow gradient of the Isaac River, with south-easterly trending hydraulic gradients. Groundwater elevations range from around 188 m AHD in the north-west, down to 155 m AHD in the south-east (SLR 2021).

While water within the Isaac River is largely fresh, water within the alluvium has recorded ranges from fresh to saline. Water within the regolith material is generally highly saline, but can be brackish to moderately saline. Water within the Permian coal measures can range between fresh and highly saline, but is generally saline within the coal seams, and brackish to moderately saline within the interburden units (SLR 2021).

1.4.6 Land Use

Land use within the Isaac River sub-basin is primarily cattle grazing and coal mining (Burgess 2003; Rollason & Howell 2012; DPM Envirosciences 2018). Although broad-scale clearing is evident throughout the wider catchment, the riparian zone is typically in good condition, with moderate coverage of vegetation and minimal erosion.

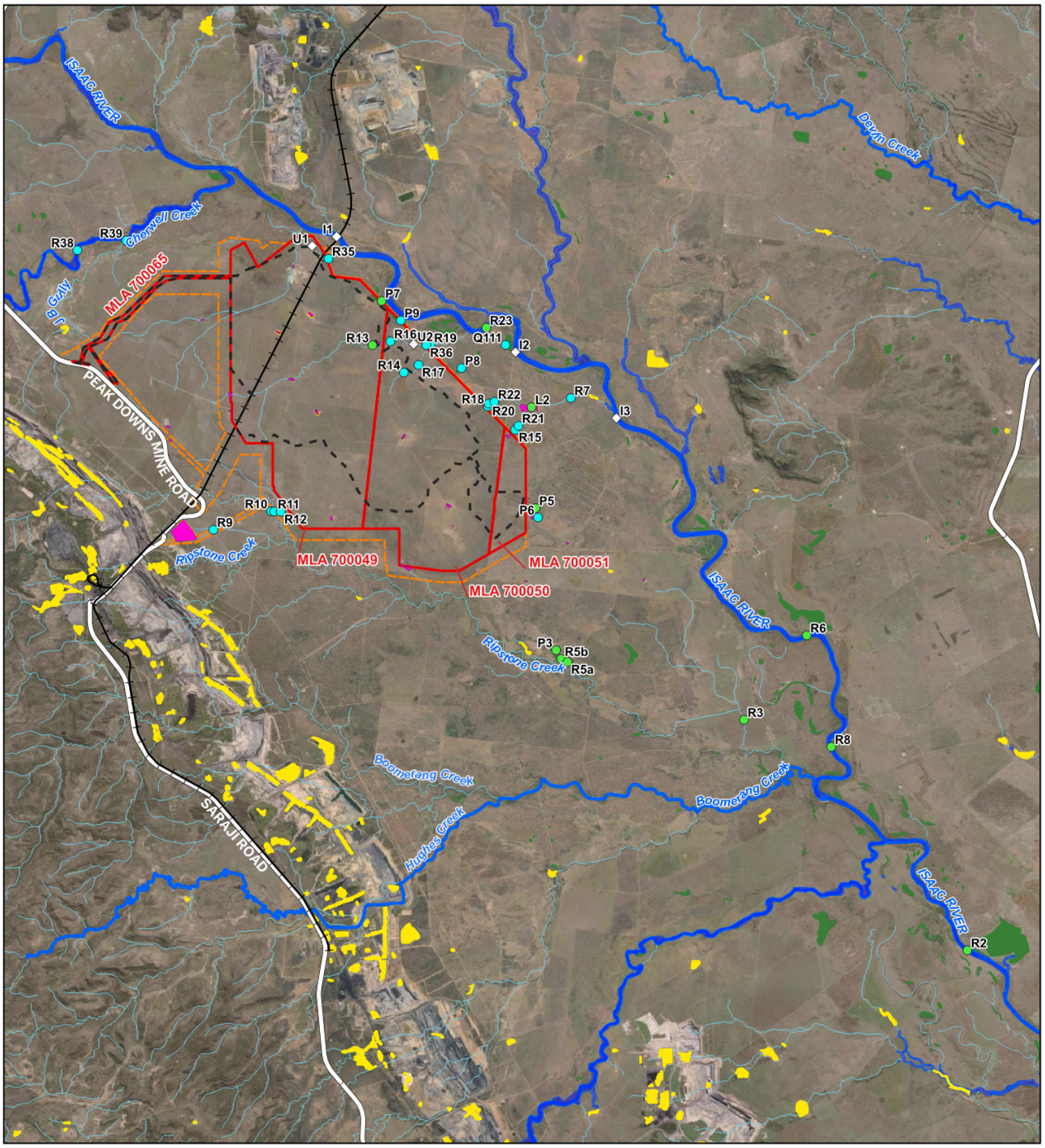
1.4.7 Previous Aquatic Ecology Studies within the Study Area

In September 2012, frc environmental prepared an aquatic ecology baseline study report (frc environmental 2012) for the area of Mineral Development Licence (MDL) 183. The Study area was confined to MDL 183 and waterways in the immediate surroundings for the purposes of frc's work. Overall, two surveys were undertaken: one in the early-wet season (28 November to 29 November 2011) and one in the post-wet season (30 April to 1 May 2012).

Conditions during the early-wet season survey were dry (< 20 mm rain for the month of November at the nearby Iffley station), although a total of approximately 17 mm of rain had been recorded over the three days prior to the survey (BOM 2019a). Temperature data for the Moranbah region are not available for the period of this survey, however at the nearest weather station (Clermont Airport) temperatures ranged from 19.1 degrees Celsius (°C) to 35.5 °C (BOM, 2019a). Conditions during the post-wet season survey were also relatively dry with < 35 mm rain falling within the month prior to the survey at the Moranbah Airport station (BOM 2019a). However, the month of March (one month prior to the survey) had seen approximately 200 mm of rain. Temperatures in the Moranbah region ranged from 10.7 °C to 28.7 °C during this survey.

Surveys were completed at five sites:

- two sites within the MDL 183 on the eastern edge (both within unnamed tributaries),
- one site in the Isaac River, upstream of MDL 183, and
- two sites in the Isaac River, downstream of MDL 183 (Map 5).



Legend

- FRC Environmental (2012) site - comprehensive
- DPM Enviroscience (2018) site - habitat
- DPM Enviroscience (2018) site - comprehensive
- Indicative surface disturbance extent
- Winchester South MLA
- Primary study area
- Railway
- Road

Waterways and Wetlands*

- Lacustrine wetland
- Palustrine wetland
- Riverine wetland
- Waterway - major
- Waterway - minor
- Farm dam**

* as per Government mapping and not ground-truthed
** note farm dams were ground-truthed from surveys conducted in May and October 2019

Map 5: Location of aquatic ecology sites surveyed during previous assessments in the vicinity of the Winchester South Project

Project Number: 1845
Author: JK
Date: 02 November 2020
Datum: GDA94
Data Sources:
© DES2020; DNRME 2020; DPM 2018; DTMR 2020; frc environmental 2012; Esri 2020; E2M 2020

0 1 2 3 4 km

Habitat quality was moderate across the five survey sites. Streambed scouring and/or deposition were reported to be common at all sites within the Isaac River. Erosion due to trampling from livestock typically left the stream banks with average stability at all sites. In-stream habitat features were variable between sites, with limited habitat features in two of the Isaac River survey sites, some woody debris at one Isaac River site downstream of MDL 183, and plentiful woody debris and detritus in the two unnamed tributaries within MDL 183. One unnamed tributary also had scattered aquatic plants and some cobbles. Riparian vegetation was largely intact along the Isaac River, but was mostly cleared along the unnamed tributaries. Weeds were generally only present during the early-wet season and not the post-wet season survey.

Water quality in-situ was variable across sites. In general, pH was within the Fitzroy Basin Water Quality Objectives (WQO) at all sites, while electrical conductivity (EC) and turbidity were generally below the WQO. Dissolved oxygen was within the WQO range at three sites but was outside the WQO range at two sites (one above and the other below).

A total of twelve aquatic plant species were identified in both surveys, none of which were listed under the *Nature Conservation Act 1992* (NC Act) or EPBC Act. In general, macroinvertebrate communities were typically dominated by non-biting midges (sub-family Tanypodinae and Chironiminae), biting midges (family Ceratopogonidae) and mayflies (family Caenidae), but compositions varied between sites likely due to varying water availability and flow.

Overall, taxonomic richness and abundance varied greatly between sites, and edge habitats tended to score better than bed habitats. However, taxonomic richness and abundance were generally below the Fitzroy Basin WQO range. Plecoptera, Ephemeroptera and Trichoptera (PET) richness and SIGNAL 2 scores of macroinvertebrates were generally higher at sites on the Isaac River, indicating better quality water and habitat for sensitive macroinvertebrates at these sites. Both PET richness and SIGNAL 2 scores were within the Fitzroy Basin WQO range at most sites. Macrocrustaceans were common at each survey site, and four taxa were recorded over both surveys. No macrocrustaceans listed under the NC Act or EBPC Act were recorded. A total of 10 native fish species were recorded over both surveys, all of which are common to the Isaac River sub-basin and none of which were listed under the NC Act or EPBC Act. No turtles or platypus (*Ornithorhynchus anatinus*) were observed within the Study area.

2 Methods

2.1 Aquatic Ecology Assessment

2.1.1 Desktop Review

In accordance with the relevant EIS Information Guidelines (former DEHP 2019a,b), a comprehensive desktop assessment was completed to describe the aquatic habitat, flora and fauna of the Study area. The following sources were reviewed:

- EPBC Act *Protected Matters Search Tool* (DAWE 2020a) and the *Queensland Wildlife Online* database (Department of Environment and Science [DES] 2020f) to determine the aquatic species (included listed threatened species) that may or are likely to occur in the waterways or wetlands in the vicinity of the Project (i.e. within 30 km of the Project area) (see Appendix A),
- database searches of the species occurring in the area, including the *Atlas of Living Australia* (ALA 2020) and the Qld Government's *WetlandInfo* (DES 2020b) species lists for the Isaac River sub-basin and Fitzroy River basin,
- publicly available water quality data from Qld Department of Natural Resources, Mines and Energy (DNRME) *Water Monitoring Information Portal* (DNRME 2019),
- existing mapping of the aquatic ecological values in the vicinity of the Project, including but not limited to the Qld Government's *Wetland Maps* mapping (DES 2020g), *Waterways for Waterway Barrier Works* spatial layer (Department of Agriculture and Fisheries [DAF] 2020), *Watercourse Identification Map* (Qld Government 2020), and the *Development Assessment Mapping System* (Department of State Development, Manufacturing, Infrastructure and Planning 2019) and the BOM Groundwater *Dependent Ecosystem Atlas* (BOM 2019b),
- aquatic ecology studies previously completed in the vicinity of the Project, including baseline assessments for Winchester South Project in 2011 and 2012 (frc environmental 2012) and more recently for the adjacent Olive Downs Project EIS (DPM Enviros ciences 2018), and
- publicly available reports from aquatic ecology assessments completed in the region, including but not limited to the Red Hill Mining Lease EIS (URS Australia Pty Ltd [URS] 2013), *Aquatic Conservation Assessments (ACA) using AquaBAMM, for the non-riverine wetlands of the Great Barrier Reef catchment* (Rollason & Howell 2012), *Land Resources Assessment of the Windeyers Hill Area, Isaac-Connors and Mackenzie River Catchments, Central Queensland* (Burgess 2003), the *Preliminary investigation into the distribution of Tilapia in the Upper Fitzroy Catchment* (Catchment Solutions 2015), and *The Biology and Management Strategies for Freshwater Turtles in the Fitzroy Catchment, with particular emphasis on Elseya albagula and Rheodytes leukops: A Study initiated in response to the proposed construction of Rosewood Weir and the raising of Eden Bann Weir* (Limpus et al. 2011).

The aquatic ecology field survey sites by DPM Enviros ciences (2018) included waterways and wetlands within the vicinity of the Project, which were surveyed for aquatic habitat, flora, fauna and water quality. Available data from DPM Enviros ciences (2018) for sites within the vicinity of the Project were reviewed and summarised, and used to enhance the descriptions of the existing environment. The locations of the relevant sites are displayed on Map 5 and Table 2.1 indicates if these sites correspond to any sites surveyed by ESP for the current assessment.

2.1.2 Field Surveys

2.1.2.1 Survey Timing

The aquatic ecology surveys previously undertaken (Section 1.4.7) were supplemented with additional field surveys that were completed in both the late-wet season and early-wet season.

The late-wet season aquatic ecology survey was completed from 15 to 22 May 2019. The weather was dry and sunny with temperatures ranging from 12 – 30°C. Rainfall in the months leading up to the survey was variable. The rainfall in January and February, which are typically the wettest months of the year, was lower than average (only 60 mm of rainfall recorded in January and less than 30 mm of rainfall recorded in February) (BOM 2019a). However, significant rainfall was recorded in March, with 135 mm recorded between 17 and 30 March 2019, which is much higher than the monthly average for the region (BOM 2019a). Rainfall in the six weeks leading up to the survey was low, with less than 10 mm recorded in April and less than 5 mm recorded at the start of May (BOM 2019a) (Figure 2.1).

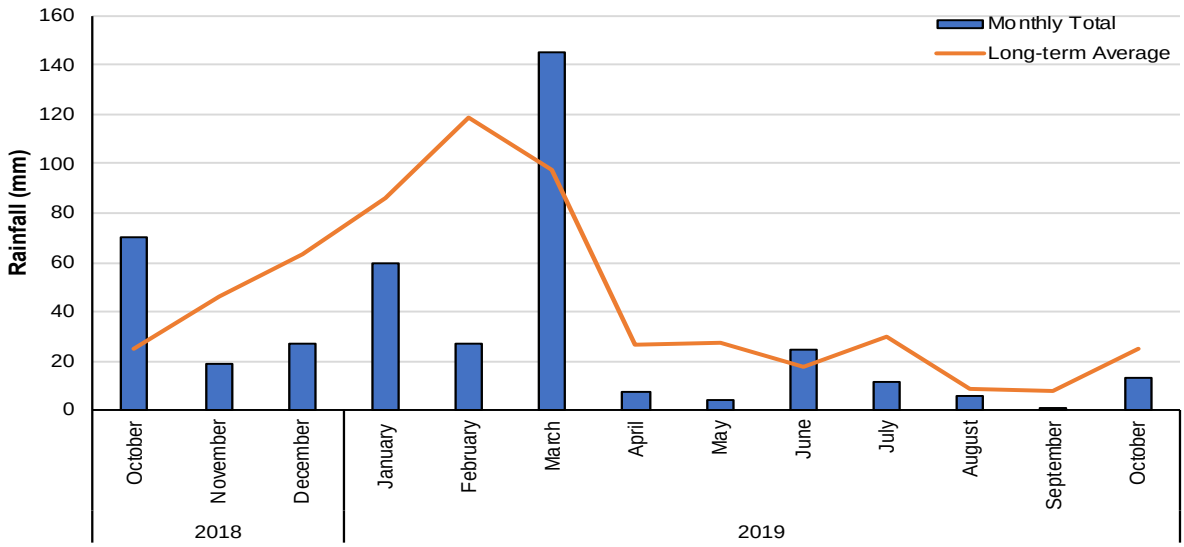


Figure 2.1 Monthly average and recorded rainfall data leading up to the May and October 2019 surveys

While no flow was recorded upstream of the Study area at Goonyella (station 130414A), flow was recorded at Deverill (station 130410A) immediately downstream of the Project; with minor flows recorded in November and December 2018 and significant flow recorded in March 2019, which reflect periods of rainfall (DNRME 2019) (Figure 2.2).

Table 2.1 Aquatic ecology sites surveyed and parameters surveyed for at each site during previous aquatic ecology surveys, and corresponding sites surveyed during the current assessment

Location	Previous Aquatic Ecology Survey Site Reference	Corresponding ESP Site[a]	Previous Aquatic Ecology Survey Methods					Previous Aquatic Ecology Survey Reference
			Habitat	Fish	Turtles	Macro-invertebrates	Plants	
Upstream of Project Area								
Cherwell Creek	R38	CK1	Y	–	–	–	Y	DPM Enviros ciences 2018
JB Gully	R39	–	Y	–	–	–	Y	DPM Enviros ciences 2018
Isaac River	I1	I1	Y	Y	–	Y	Y	frc environmental 2012
Adjacent to Project Area								
Ripstone Creek and tributaries	R10	RCT1/ RCT1a	Y	–	–	–	Y	DPM Enviros ciences 2018
	R11	RCT1, RCT1a	Y	–	–	–	Y	DPM Enviros ciences 2018
	R12	RCT2	Y	–	–	–	Y	DPM Enviros ciences 2018
	R9	RCT3	Y	–	–	–	Y	DPM Enviros ciences 2018
Within Project Area								
Central unnamed waterway and tributaries	R13	–	Y	Y	Y	Y	Y	DPM Enviros ciences 2018
	R14	–	Y	–	–	–	Y	DPM Enviros ciences 2018
Downstream of Project Area								
Palustrine wetlands	Q111	PW1	Y	–	–	–	Y	DPM Enviros ciences 2018
	P8	–	Y	–	–	–	Y	DPM Enviros ciences 2018
	P5	–	Y	Y	Y	Y	Y	DPM Enviros ciences 2018
	P6	–	Y	–	–	–	Y	DPM Enviros ciences 2018
	P3	–	Y	Y	Y	Y	Y	DPM Enviros ciences 2018
Northern unnamed waterway and tributaries	U1	U1	Y	Y	–	Y	Y	frc environmental 2012
	R35	–	Y	–	–	–	Y	DPM Enviros ciences 2018
Central unnamed waterway and tributaries	R16	–	Y	–	–	–	Y	DPM Enviros ciences 2018
	U2	U2	Y	Y	–	Y	Y	frc environmental 2012
	R36	U2	Y	–	–	–	Y	DPM Enviros ciences 2018
	R19	–	Y	–	–	–	Y	DPM Enviros ciences 2018
	R17	U7	Y	–	–	–	Y	DPM Enviros ciences 2018
	R18	U5	Y	–	–	–	Y	DPM Enviros ciences 2018

Location	Previous Aquatic Ecology Survey Site Reference	Corresponding ESP Site[a]	Previous Aquatic Ecology Survey Methods					Previous Aquatic Ecology Survey Reference
			Habitat	Fish	Turtles	Macro-invertebrates	Plants	
Southern unnamed waterway and tributaries	R20	–	Y	–	–	–	Y	DPM Enviros ciences 2018
	R22	–	Y	–	–	–	Y	DPM Enviros ciences 2018
	R15	U6	Y	–	–	–	Y	DPM Enviros ciences 2018
	R21	–	Y	–	–	–	Y	DPM Enviros ciences 2018
	L2	LW5	Y	Y	Y	Y	Y	DPM Enviros ciences 2018
	R7	–	Y	–	–	–	Y	DPM Enviros ciences 2018
Isaac River	R23	I2a	Y	Y	Y	Y	Y	DPM Enviros ciences 2018
	I2	–	Y	Y	–	Y	Y	frc environmental 2012
	I3	I3	Y	Y	–	Y	Y	frc environmental 2012
	R6	–	Y	Y	Y	Y	Y	DPM Enviros ciences 2018
	R8	–	Y	Y	Y	Y	Y	DPM Enviros ciences 2018
	R2	–	Y	–	–	Y	Y	DPM Enviros ciences 2018
Palustrine wetlands	P7	PW2	Y	Y	–	Y	Y	DPM Enviros ciences 2018
	P9	PW3	Y	–	–	–	Y	DPM Enviros ciences 2018
Ripstone Creek and tributaries	R5a	–	Y	–	–	–	Y	DPM Enviros ciences 2018
	R5b	–	Y	Y	Y	Y	Y	DPM Enviros ciences 2018
	R3	–	Y	Y	Y	Y	Y	DPM Enviros ciences 2018

[a] corresponding ESP sites within 50 – 500 m of sites surveyed as part of previous assessments; all located on the same waterway.

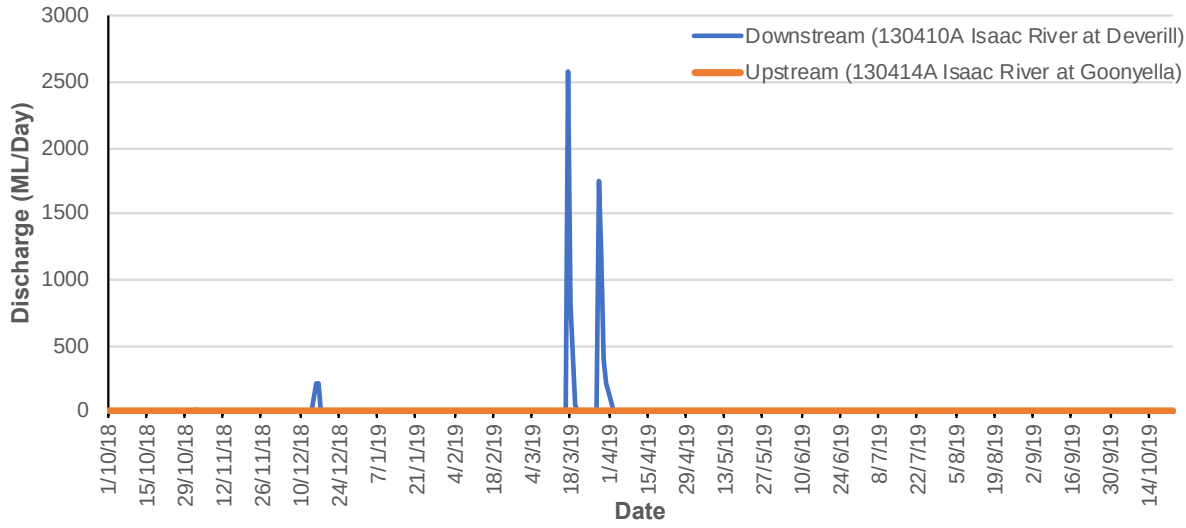


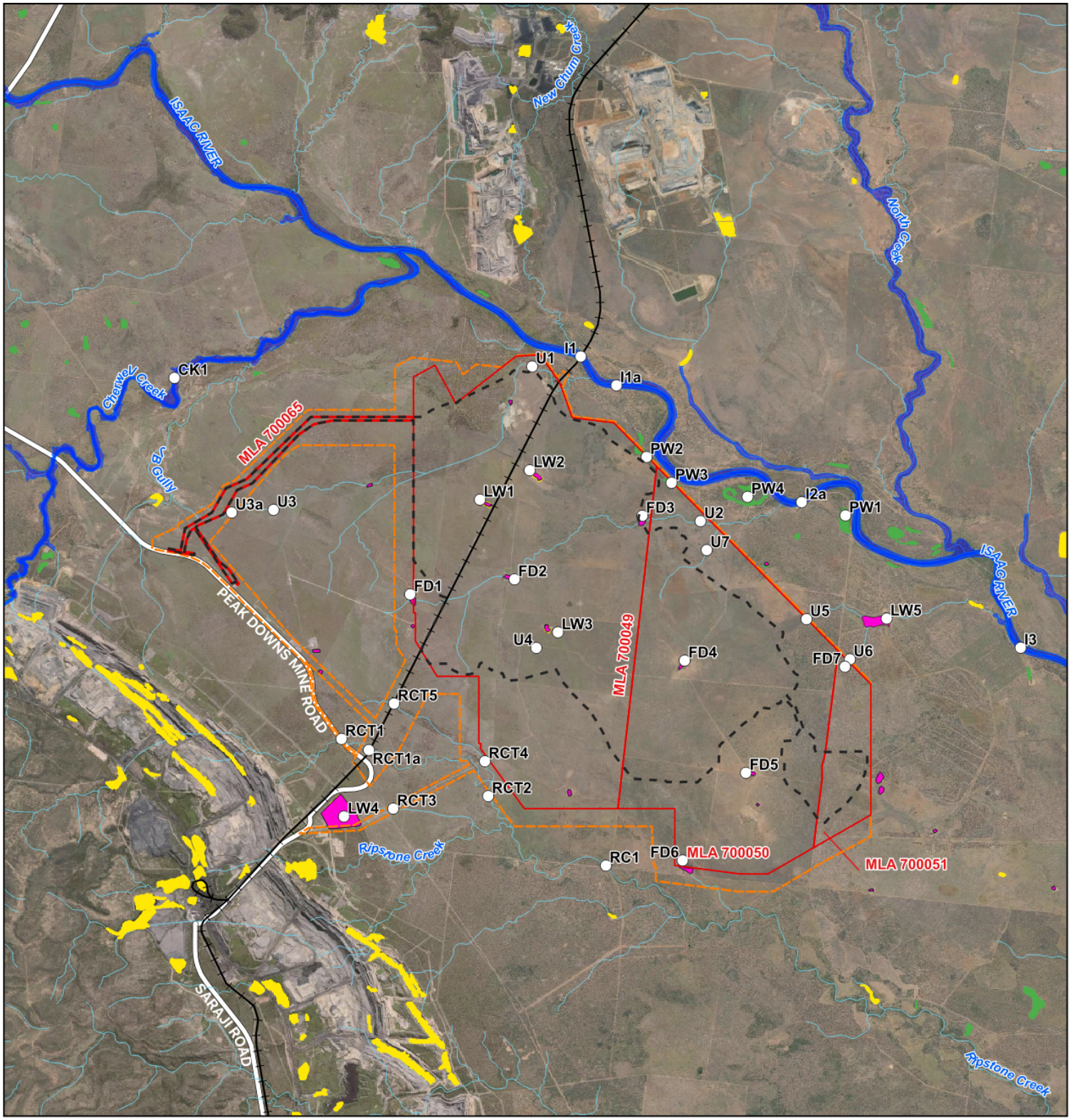
Figure 2.2 Stream flow recorded leading up to the May and October 2019 surveys

The early-wet season aquatic ecology survey was completed from 14 to 22 October 2019. The weather was dry and sunny, with temperatures ranging from 15 – 39°C and rainfall in the months prior to the survey was low. Rainfall between June and October was below the long-term average for the region, except in June when 25 mm was recorded. Some rain was recorded in the week leading up to the survey with 13 mm recorded between 11 and 12 October (BOM 2019a) (Figure 2.1), however this was not considered significant enough to alter the conditions on-site. Furthermore, no flow was recorded in the Isaac River upstream or downstream of the Project in the months leading up to the survey, which is reflective of the dry conditions (DNRME 2019; Figure 2.2).

2.1.2.2 Site Locations

A total of 36 sites were surveyed, located upstream, within and downstream of the Project (Table 2.2; Map 6). Not all sites were sampled during both surveys; additional sites were surveyed in October 2019 to ensure a comprehensive assessment of all waterways and wetlands within the vicinity of the Project was completed (Table 2.3).

Aquatic ecological indicators surveyed at each site during the field surveys is presented in Table 2.3. Certain sites were selected to be surveyed as habitat assessment sites. At each of these sites, a sub-set of indicators were surveyed, including: aquatic habitat, in-situ water quality (if water was present), and aquatic ecological value. At all other sites comprehensive aquatic ecology assessments were completed, which included: aquatic habitat, in-situ and analytical water quality (if water was present), sediment quality, aquatic plants, macroinvertebrates (if water was present), fish (if water was present) and turtles (if water was present and appropriate habitat was identified) and aquatic ecological value.



Legend

- Indicative surface disturbance extent
- Survey site
- Winchester South MLA
- Primary study area
- Road
- Railway

Waterways and Wetlands*

- Waterway - major
- Waterway - minor
- Riverine wetland
- Lacustrine wetland
- Palustrine wetland
- Dam**

*as per Government mapping and not ground-truthed
**note farm dams were ground-truthed from surveys conducted in May and October 2019

Map 6: Location of aquatic ecology sites surveyed in May and October 2019

Project Number: 1845
Author: JK
Date: 02 November 2020
Datum: GDA94
Data Sources:
© DES 2020; DNRME 2020; DTMR 2020; Esri 2020; E2M 2020

0 1 2 3 4 km

A sub-set of the aquatic ecology and habitat assessment sites were located on potential surface-expression GDEs mapped in the *Groundwater Dependent Ecosystems Atlas* (BOM 2019b) (Table 2.3, Map 7). The likelihood of these sites (and other wetlands) being GDEs was evaluated in accordance with the guidelines for identifying and characterising GDEs outlined in the *Information guidelines note: Assessing groundwater-dependent ecosystems* (Doody et al. 2019). The results of this assessment are presented in Section 3.8.

Table 2.2 Survey site names, locations and coordinates for each site surveyed in May and October 2019

Location / Site	Description	Latitude	Longitude
Upstream of the Project Area			
CK1	Cherwell Creek	-22.1218	148.1734
I1	Isaac River	-22.1164	148.2771
U3	Tributary of the northern unnamed waterway	-22.1555	148.1987
U3a	Tributary of the northern unnamed waterway	-22.1562	148.1880
FD1	Unmapped farm dam on the central unnamed waterway	-22.1783	148.2343
Adjacent to the Project Area			
RC1	Ripstone Creek	-22.2463	148.2835
RCT1	Tributary of Ripstone Creek	-22.2140	148.2160
RCT1a	Tributary of Ripstone Creek	-22.2168	148.2230
RCT2	Tributary of Ripstone Creek	-22.2299	148.2531
RCT3	Tributary of Ripstone Creek	-22.2319	148.2322
RCT4	Tributary of Ripstone Creek	-22.2189	148.2529
RCT5	Tributary of Ripstone Creek	-22.2050	148.2294
LW4	Mapped lacustrine wetland	-22.2364	148.2171
FD5	Unmapped farm dam not on mapped waterway	-22.2225	148.3200
FD6	Unmapped farm dam on a tributary of Ripstone Creek	-22.2479	148.3049
Within the Project Area			
LW1	Mapped lacustrine wetland	-22.1539	148.2530
LW2	Mapped lacustrine wetland	-22.1469	148.2661
LW3	Mapped lacustrine wetland	-22.1864	148.2684
FD2	Unmapped farm dam on the central unnamed waterway	-22.1728	148.2586
FD4	Unmapped farm dam not on mapped waterway	-22.1952	148.3028
U4	Tributary of the central unnamed waterway (unmapped)	-22.1908	148.2658
Downstream of the Project Area			
I1a	Isaac River	-22.1237	148.2862
I2a	Isaac River	-22.1535	148.3335
I3	Isaac River	-22.1907	148.3893
U1	Northern unnamed waterway	-22.1189	148.2647
U2	Central unnamed waterway	-22.1584	148.3076
U5	Tributary of the southern unnamed waterway	-22.1834	148.3347
U6	Tributary of the southern unnamed waterway	-22.1937	148.3458
U7	Tributary of the central unnamed waterway	-22.1658	148.3092
PW1	Mapped HES/WPA palustrine wetland in Isaac River floodplain	-22.1569	148.3446

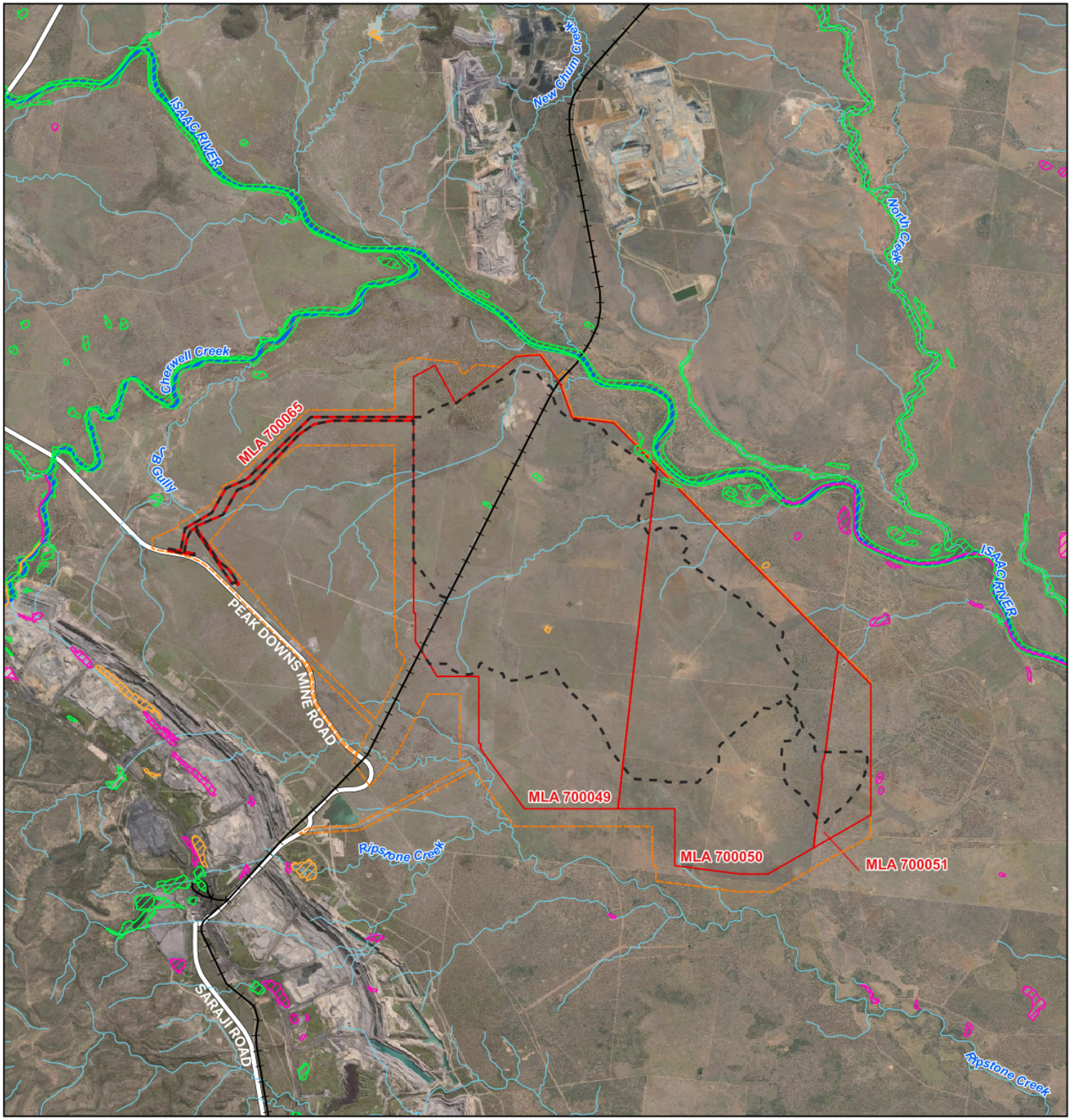
Location / Site	Description	Latitude	Longitude
PW2	Mapped palustrine wetland	-22.1420	148.2939
PW3	Mapped palustrine wetland	-22.1486	148.3002
PW4	Mapped palustrine wetland in Isaac River floodplain	-22.1522	148.3197
LW5	Mapped lacustrine wetland on the southern unnamed waterway	-22.1833	148.3551
FD3	Unmapped farm dam on the central unnamed waterway	-22.1586	148.2931
FD7	Unmapped farm dam on a tributary of southern unnamed waterway	-22.1954	148.3443

Table 2.3 Assessment completed at each site and ecological indicators sampled for per survey in May and October 2019

Location / Site	May 2019									October 2019								
	Assessment type	Aquatic habitat	In-Situ water quality	Analytical water quality	Sediment quality	Aquatic plants	Macro-invertebrates	Fish	Turtles	Assessment type	Aquatic habitat	In-situ water quality	Analytical water quality	Sediment quality	Aquatic plants	Macro-invertebrates	Fish	Turtles
Upstream of the Project Area																		
CK1	*H^, G*	Y	NS	–	–	–	–	–	–	*H^, G*	Y	NS	–	–	–	–	–	–
I1	*C, G*	Y	Y	Y	Y	Y	Y	Y	NS	*C^, G*	Y	NS	NS	Y	Y	NS	NS	NS
U3	*C^*	Y	NS	NS	NS	NS	NS	NS	NS	*C^*	Y	NS	NS	Y	Y	NS	NS	NS
U3a	*–*	–	–	–	–	–	–	–	–	*H^*	Y	NS	–	–	–	–	–	–
FD1	*H*	Y	Y	–	–	–	–	–	–	*H*	Y	Y	–	–	–	–	–	–
Adjacent to the Project Area																		
RC1	*C^*	Y	NS	NS	Y	Y	NS	NS	NS	*C^*	Y	NS	NS	Y	Y	NS	NS	NS
RCT1	*H^*	Y	NS	–	–	–	–	–	–	*H^*	Y	NS	–	–	–	–	–	–
RCT1a	*–*	–	–	–	–	–	–	–	–	*H^*	Y	NS	–	–	–	–	–	–
RCT2	*H^*	Y	NS	–	–	–	–	–	–	*H^*	Y	NS	–	–	–	–	–	–
RCT3	*H*	Y	Y	–	–	–	–	–	–	*H^*	Y	NS	–	–	–	–	–	–
RCT4	*C*	Y	Y	Y	Y	Y	Y	Y	NS	*C^*	Y	NS	NS	Y	Y	NS	NS	NS
RCT5	*–*	–	–	–	–	–	–	–	–	*H^*	Y	NS	–	–	–	–	–	–
LW4	*H*	Y	Y	–	–	–	–	–	–	*–*	–	–	–	–	–	–	–	–
FD5	*–*	–	–	–	–	–	–	–	–	*H*	Y	Y	–	–	–	–	–	–
FD6	*–*	–	–	–	–	–	–	–	–	*C*	Y	Y	Y	Y	Y	Y	Y	Y
Within the Project Area																		
LW1	*–*	–	–	–	–	–	–	–	–	*H^, G*	Y	NS	–	–	–	–	–	–
LW2	*H, G*	Y	Y	–	–	–	–	–	–	*H^, G*	Y	NS	–	–	–	–	–	–
LW3	*H, G*	Y	Y	–	–	–	–	–	–	*H, G*	Y	Y	–	–	–	–	–	–
FD2	*C*	Y	Y	Y	Y	Y	Y	Y	Y	*C*	Y	Y	Y	Y	Y	Y	Y	Y
FD4	*–*	–	–	–	–	–	–	–	–	*C*	Y	Y	Y	Y	Y	Y	Y	Y
U4	*C*	Y	Y	Y	Y	Y	Y	Y	NS	*C^*	Y	NS	NS	Y	Y	NS	NS	NS

Location / Site	May 2019									October 2019								
	Assessment type	Aquatic habitat	In-Situ water quality	Analytical water quality	Sediment quality	Aquatic plants	Macro-invertebrates	Fish	Turtles	Assessment type	Aquatic habitat	In-situ water quality	Analytical water quality	Sediment quality	Aquatic plants	Macro-invertebrates	Fish	Turtles
Downstream of the Project Area																		
I1a	–	–	–	–	–	–	–	–	–	*C, G*	Y	Y	Y	Y	Y	Y	Y	Y
I2a	*C, G*	Y	Y	Y	Y	Y	Y	Y	NS	*C^, G*	Y	NS	NS	Y	Y	NS	NS	NS
I3	*C, G*	Y	Y	Y	Y	Y	Y	Y	Y	*C^, G*	Y	NS	NS	Y	Y	NS	NS	NS
U1	*C*	Y	Y	Y	Y	Y	Y	Y	NS	*C^*	Y	NS	NS	Y	Y	NS	NS	NS
U2	*C^*	Y	NS	NS	NS	NS	NS	NS	NS	*C^*	Y	NS	NS	Y	Y	NS	NS	NS
U5	–	–	–	–	–	–	–	–	–	*H^*	Y	NS	–	–	–	–	–	–
U6	–	–	–	–	–	–	–	–	–	*H^*	Y	NS	–	–	–	–	–	–
U7	–	–	–	–	–	–	–	–	–	*H^*	Y	NS	–	–	–	–	–	–
PW1	*C^, G*	Y	NS	NS	Y	Y	NS	NS	NS	*C^, G*	Y	NS	NS	Y	Y	NS	NS	NS
PW2	*H^, G*	Y	NS	–	–	–	–	–	–	*H^, G*	Y	NS	–	–	–	–	–	–
PW3	*H^, G*	Y	NS	–	–	–	–	–	–	*H^, G*	Y	NS	–	–	–	–	–	–
PW4	*C^, G*	Y	NS	NS	Y	Y	NS	NS	NS	*C^, G*	Y	NS	NS	Y	Y	NS	NS	NS
LW5	–	–	–	–	–	–	–	–	–	*H, G*	Y	Y	–	–	–	–	–	–
FD3	–	–	–	–	–	–	–	–	–	*H*	Y	Y	–	–	–	–	–	–
FD7	–	–	–	–	–	–	–	–	–	*H*	Y	Y	–	–	–	–	–	–

H Habitat assessment
C Comprehensive assessment
G Surface-expression GDE assessment
^ Site dry at the time of the survey
– Not surveyed
Y Indicator sampled
NS Indicator not sampled as appropriate habitat features or sufficient water not available



Legend

- Indicative surface disturbance extent
- Winchester South MLA
- Primary study area
- Road
- Railway

Waterways and Wetlands*

- Waterway - major
- Waterway - minor

Mapped potential terrestrial GDEs*

- High potential GDE from national assessment
- Moderate potential GDE from national assessment
- Low potential GDE from national assessment

*as per Government mapping and not ground-truthed

Map 7: Mapped potential Groundwater Dependent Ecosystems within the vicinity of the Project (based on the national dataset of Australian GDEs)

Project Number: 1845
Author: JK
Date: 02 November 2020
Datum: GDA94
Data Sources:
© BOM2019; DES 2020; DNRME 2020; DTMR 2020; Esri 2020

0 1 2 3 4 km

2.1.2.3 Aquatic Habitat

Aquatic habitat assessments were completed to describe the aquatic habitat condition, connectivity and ecosystem value of each site. Assessments were based on the Australian River Assessment System (AUSRIVAS) habitat assessment protocol (Department of Natural Resources and Mines [DNRM] 2001), modified where required to suit the purpose of this study (e.g. additional assessments to adequately identify the presence and value of potential habitat for listed threatened species). Observations for aquatic habitat value included:

- features of the water body, including bank height, estimate of flow, estimated width and depth of any standing water present,
- details of the riparian zone (e.g. width, canopy height, species present) and adjacent land use,
- aquatic habitat types present and their relative percent cover within the reach,
- details of the sediment types present (e.g. relative composition of grain sizes, presence of anoxic sediments),
- details regarding any evidence of disturbances or impacts (if present) on aquatic ecosystems, and
- overall habitat condition and value.

Habitat assessments were completed using an electronic template to avoid transcription errors. Georeferenced photographs of the reach and key habitat features were also taken at each site. The aquatic habitat at each site was summarised and to assist interpretation of the biological survey results.

At each site holding water (excluding wetland and dam sites), overall habitat condition was assessed based on the river bioassessment score protocol described in the *Queensland Australian River Assessment System (AusRIVAS) Sampling and Processing Manual* (DNRM 2001). Each site was assessed on a number of criteria and given a numeric score for each criterion. The sum of the numerical score from each criterion produced an overall habitat condition score that allocated each site to one of four categories:

- >110 were considered to be in excellent condition,
- between 75 and 110 were considered to be in good condition,
- between 39 and 74 were considered to be in moderate condition, and
- ≤38 were considered to be in poor condition.

At each wetland site, ground-truthing was conducted to assess the extent of each wetland as per the *Queensland Wetland Definition and Delineation Guideline – Part A: A Guide to Existing Wetland Definitions and the Application of the Queensland Wetland Program Definition* (Department of Environment and Resource Management [DERM] 2010) and the *Queensland Wetland Definition and Delineation Guideline – Part B: Delineation and Mapping Guideline* (DERM 2011).

2.1.2.4 Water Quality

The surface water quality assessment was not designed as a comprehensive baseline survey of water quality for the Project. Instead, surface water quality data was collected to provide an indication of the condition of water quality at the time of the surveys in order to inform the interpretation of biological survey results.

At each site that held sufficient water (Table 2.3), physicochemical water quality (temperature, conductivity, pH, dissolved oxygen and turbidity) was measured using a YSI ProDSS multi-parameter water quality sonde at a depth of 20 centimetres (cm) below the water surface. The water quality meter was calibrated prior to field sampling.

At each comprehensive aquatic ecology site that held sufficient water (Table 2.3), grab samples were also collected from 30 cm below the water surface for analysis of:

- total dissolved solids (TDS) and total suspended solids (TSS),
- nutrients (total nitrogen, nitrate, nitrite, oxides of nitrogen (NOx), ammonia, Total Kjeldahl Nitrogen (TKN), reactive and total phosphorous),
- total hardness,
- major ions (calcium, fluoride, magnesium, potassium, sodium and sulphate),
- total and dissolved metals and metalloids (aluminium, arsenic, boron, cadmium, chromium, cobalt, copper, lead, iron, manganese, mercury, molybdenum, nickel, selenium, silver, uranium, vanadium and zinc),
- total petroleum hydrocarbons (TPHs), and
- benzene, toluene, ethylbenzene, xylene and naphthalene (BTEXN).

Quality assurance / quality control (QA/QC) measures for water quality sampling and analyses were in accordance with the *Monitoring and Sampling Manual: Environmental Protection (Water) Policy 2009* (DES 2018a). This included the use of powder-free nitrile gloves, which were worn during sample container handling, to reduce the risk of sample contamination during collection. All samples were held under the appropriate conditions (e.g. in eskies in the field and during transport) and delivered to ALS Environmental (a NATA-accredited laboratory) within the required holding timeframes.

A duplicate field sample (i.e. sample split into two) and field method blank were collected from one site during each survey, to determine the variability in results associated with field sampling. A relative percent difference (RPD) of <20% between field replicates was deemed acceptable (where the values were more than five to ten times the laboratory limit of reporting [LOR]) (DES 2018a). The laboratory also completed quality control measures including analysis of blanks, spikes and duplicates. A Certificate of Analysis for water quality samples is provided in Appendix B.

Results were reviewed, and all parameters below or equal to the LOR at all sites were noted and not considered further. Results for remaining parameters were compared to available WQOs (Table 2.4) adopted from the following sources:

- WQOs for upper Isaac River catchment freshwaters (used for comparison to waterway sites) and lakes/reservoirs (for lacustrine wetland and farm dam sites) scheduled in the EPP (Water and Wetland Biodiversity) for the Isaac River sub-basin (EHP 2013a),
- default guideline values (DGVs) for slightly to moderately disturbed ecosystems for 95% level of protection (unless otherwise recommended) published in the National water quality guidelines (Australian and New Zealand Governments [ANZG] 2018), and
- trigger levels (TLs) for aquatic ecosystem protection specified in the *Model Water Conditions for Coal Mines in the Fitzroy Basin* (DES 2013).

Table 2.4 Relevant Water Quality Objectives (WQOs) for the analysed parameters

Parameter	Units	Freshwater [a]	Lakes and Reservoirs [b]
Physical			
Temperature	°C	–	–
pH	pH units	6.5 – 8.5	6.5 – 8.0
EC	µS/cm	< 720 [c]	< 250 [c]
Dissolved oxygen	%Sat	85 –110	90 –110
Turbidity	NTU	< 50	1 – 20
TDS	mg/L	–	–
TSS	mg/L	< 55	–
Major Ions			
Total hardness as $CaCO_3$	mg/L	–	–
Sulfate as SO_4	mg/L	< 25	–
Calcium	mg/L	–	–
Magnesium	mg/L	–	–
Sodium	mg/L	–	–
Potassium	mg/L	–	–
Fluoride	mg/L	2	
Nutrients			
Ammonia	µg/L	< 20	< 10
Nitrite as N	µg/L	–	–
Nitrate as N	µg/L	–	–
Oxides of nitrogen	µg/L	< 60	< 10
Organic nitrogen	µg/L	< 420	< 330
TKN	µg/L	–	–
Total nitrogen	µg/L	< 500	< 350
Total phosphorus	µg/L	< 50	< 10
Filterable reactive phosphorous	µg/L	< 20	< 5
Metals and Metalloids [d]			
Aluminium	µg/L	55	
Arsenic	µg/L	13 [e]	
Boron	µg/L	370	
Cadmium	µg/L	$0.2x(H/30)^{0.89}$ [f]	
Chromium	µg/L	1.0 [g]	

Parameter	Units	Freshwater [a]	Lakes and Reservoirs [b]
Cobalt	µg/L	90 [h]	
Copper	µg/L	1.4	
Iron	µg/L	300 [i]	
Lead	µg/L	$3.4x(H/30)^{1.27,f}$	
Manganese	µg/L	1900	
Mercury	µg/L	0.06 [j]	
Molybdenum	µg/L	34 [k]	
Nickel	µg/L	$11x(H/30)^{0.85,f}$	
Selenium	µg/L	10 [l]	
Silver	µg/L	0.05	
Uranium	µg/L	1.0 [l]	
Vanadium	µg/L	10 [l]	
Zinc	µg/L	$8.0x(H/30)^{0.85,f}$	
Hydrocarbons			
C6 - C9 Fraction	µg/L	20 [l]	
C10 - C14 Fraction	µg/L	–	
C15 - C28 Fraction	µg/L	–	
C29 - C36 Fraction	µg/L	–	
C10 - C36 Fraction (sum)	µg/L	100 [l]	
BTEXN			
Benzene	µg/L	950	
Toluene	µg/L	–	
Ethylbenzene	µg/L	–	
Meta- & Para-Xylene	µg/L	–	
Ortho-Xylene	µg/L	350	
Total Xylenes	µg/L	–	
Naphthalene	µg/L	16	

µS/cm = microSiemens per centimetre; NTU = Nephelometric Turbidity Units; µg/L = microgram per litre; mg/L = milligrams per litre

[a] WQO for Upper Isaac River catchment moderately disturbed waters (used for comparison to waterway sites) (EHP 2013a)

[b] WQO for Upper Isaac River catchment moderately disturbed freshwater lakes/reservoirs (used for comparison to lacustrine wetland and farm dam sites) (EHP 2013a)

[c] WQO for base flow conditions (EHP 2013a)

[d] Specified WQOs to be applied to dissolved metals and metalloids only (ANZG 2018)

[e] WQOs for arsenic V adopted as a conservative approach (ANZG 2018) because analyses did not speciate arsenic

[f] WQO modified based on water hardness-dependent algorithm, where H = water hardness (ANZG 2018)

[g] WQOs for chromium VI adopted as a conservative approach (ANZG 2018) because analyses did not speciate chromium

[h] Moderate reliability WQO (ANZG 2018)

[i] Interim WQO based on Canadian guideline value, as per recommendations in ANZG (2018) and adopted in the *Model Water Conditions for Coal Mines in the Fitzroy Basin* (DES 2013)

[j] WQOs for 99% of species protection for slightly to moderately disturbed waters as per recommendations (ANZG 2018)

[k] Low reliability WQO, as per recommendations in ANZG (2018) and adopted in the *Model Water Conditions for Coal Mines in the Fitzroy Basin* (DES 2013)

[l] Trigger level differs from the default guideline value for aquatic ecosystem protection (ANZG 2018), the WQO outlined in the *Model Water Conditions for Coal Mines in the Fitzroy Basin* (DES 2013) has been adopted

2.1.2.5 Sediment Quality

At each comprehensive aquatic ecology site (Table 2.3), sediment quality in the stream channel was assessed. A single composite sample was collected from a low-flow stream bank using a stainless steel trowel, in accordance with methods outlined in the *Monitoring and Sampling Manual: Environmental Protection (Water) Policy 2009* (DES 2018a) and the guide to *Sediment Quality Assessment: A Practical Guide, Second Edition* (Simpson & Batley 2016). The composite sample comprised 5 to 10 sediment grabs collected 1 to 10 m apart along the length of each site. Samples were collected into suitable glass jars and were not mixed in the field, as this was completed by the laboratory during sample preparation for analysis.

Samples were held under the appropriate conditions (e.g. in eskies in the field and during transport) and delivered to ALS Environmental (a NATA-accredited laboratory) within the required holding timeframes for analysis of:

- 20 total metals and metalloids (aluminium, arsenic, barium, beryllium, boron, cadmium, chromium, cobalt, copper, lead, iron, manganese, mercury, molybdenum, nickel, selenium, silver, uranium, vanadium and zinc), and
- TPHs.

Strict QA/QC protocols were adhered to throughout each stage of sampling, in accordance with the *Monitoring and Sampling Manual: Environmental Protection (Water) Policy 2009* (DES 2018a). Powder-free nitrile gloves were worn during sample container handling, to reduce the risk of sample contamination during collection.

In both surveys, one field replicate sample was collected from one site and analysed for the parameters listed above to determine any small scale (i.e. within site) variation. A RPD of <50% between field replicates was deemed acceptable (DES 2018a). The laboratory also completed quality control measures including analysis of blanks, spikes and duplicates. A Certificate of Analysis report for sediment quality samples is provided in Appendix B.

The sediment quality results were reviewed, and all parameters that were below or equal to the laboratory LOR at all sites were noted and not considered further. Results for remaining parameters were compared to the DGVs and guideline value-high (GV-High) (where available) outlined in the ANZG (2018) and Simpson et al. (2013) (Table 2.5).

Table 2.5 Default guideline values (DGVs) and guideline values-high (GV-High) for sediment quality (ANZG 2018)

Parameter	Unit	DGV	GV-High [a]
Metals and Metalloids			
Aluminium	mg/kg	–	–
Arsenic	mg/kg	20	70
Barium	mg/kg	–	–
Beryllium	mg/kg	–	–
Boron	mg/kg	–	–
Cadmium	mg/kg	1.5	10.0
Chromium	mg/kg	80	370
Cobalt	mg/kg	–	–
Copper	mg/kg	65	270

Parameter	Unit	DGV	GV-High [a]
Iron	mg/kg	–	–
Lead	mg/kg	50	220
Manganese	mg/kg	–	–
Mercury	mg/kg	0.15	1.00
Molybdenum	mg/kg	–	–
Nickel	mg/kg	21	52
Selenium	mg/kg	–	–
Silver	mg/kg	1	4
Uranium	mg/kg	–	–
Vanadium	mg/kg	–	–
Zinc	mg/kg	200	410
Total Petroleum Hydrocarbons			
C6 - C9 Fraction	mg/kg	–	–
C10 - C14 Fraction	mg/kg	–	–
C15 - C28 Fraction	mg/kg	–	–
C29 - C36 Fraction	mg/kg	–	–
C10 - C36 Fraction (sum)	mg/kg	280	550

mg/kg = milligrams per kilogram dry weight.

– no GV exists for this parameter

[a] GV-high to be used as an indicator of potential high-level toxicity problems, not as a guideline value to ensure protection of ecosystems

2.1.2.6 Aquatic Plants

At each comprehensive aquatic ecology site (excluding wetland and dam sites) (Table 2.3), aquatic plant communities were semi-quantitatively assessed using ten replicated quadrats along a 100 m belt transect via visual assessment. The following were recorded in each quadrat:

- the location (i.e. on bank or in stream) of aquatic plants,
- aquatic plant growth form (i.e. submerged, emergent, floating), and
- percent cover of each species (both native and exotic).

At wetland and dam sites, aquatic plants were assessed via visual estimates of species diversity and total percent coverage within the area of the wetland or dam.

For each comprehensive aquatic ecology site, the total taxonomic richness and percent cover were calculated to inform the interpretation of biological survey results and to assess the overall aquatic ecological value of the site. For habitat sites, aquatic plant diversity and abundance was used to assess the overall aquatic ecological value of the site.

2.1.2.7 Aquatic Macroinvertebrates

At each comprehensive aquatic ecology site that held sufficient water (Table 2.3), macroinvertebrate communities (including macrocrustaceans) were surveyed to provide an assessment of ecosystem health. One AUSRIVAS sample was collected from a 10 m section of each available habitat type (e.g. bed / pool and edge) using the standard kick-sweep method (DNRM 2001). In addition, quantitative, replicated sampling was completed to provide a more robust baseline, which involved collecting five replicate macroinvertebrate samples from a 30 cm x 30 cm area within each available habitat type.

All samples were collected using a standard triangular AUSRIVAS dip net (DNRM 2001). Samples were transferred into labelled sample jars, preserved in a 70% ethanol solution and transported to ESP's laboratory for processing. The macroinvertebrates in each sample was sorted, counted and identified to the lowest practical taxonomic level (in most instances family) to comply with standard AUSRIVAS methodology (DNRM 2001). Any macrocrustaceans (e.g. yabbies and freshwater crabs) caught during fish surveys (see below) were also recorded.

Appropriate QA/QC checks were completed in accordance with the recommendations in the *Queensland Australian River Assessment System (AusRIVAS) Sampling and Processing Manual* (DNRM 2001) and the *Monitoring and Sampling Manual: Environmental Protection (Water) Policy 2009* (DES 2018a). A second ecologist checked approximately 80% of picked samples, and at least 5% of samples were re-identified and counted by a second ecologist. An error rate of <10% was considered acceptable, as per the Laboratory Identification QA/QC guidelines (DNRM 2001; DES 2018a).

Standard macroinvertebrate indices were calculated for each site, including abundance (replicate samples only), taxonomic richness and the presence of sensitive taxa through calculation of PET (Plecoptera/Ephemeroptera/Trichoptera) richness and SIGNAL2 scores (Chessman 2003). Due to very high abundances of microcrustaceans (e.g. copepods, ostracods and cladocerans) in some samples, these taxa were removed from the analysis.

Results for AUSRIVAS samples were compared against the relevant biological objectives scheduled under the EPP (Water and Wetland Biodiversity) for the Isaac River sub-basin for upper Isaac River catchment freshwaters (EHP 2013a,b) (Table 2.6). These values are derived for streams (i.e. flowing waters) and as such comparisons of results from wetlands and dams with the biological objectives should be interpreted with caution (as they are stagnant habitats). Results for replicate samples were graphed as averages for each site with standard error to indicate the amount of in-site variation.

Table 2.6 Biological guidelines values for upper Isaac River catchment freshwaters (EHP 2013a)[a]

Index	Composite [b]	Edge
Taxonomic richness	12 – 21	23 – 33
PET richness	2 – 5	2 – 5
SIGNAL score	3.33 – 3.85	3.31 – 4.20
% tolerant taxa	25 – 50%	44 – 56%

[a] Macroinvertebrate biological guidelines are based on the *Queensland Water Quality Guidelines* (QWQGs; EHP 2013b) Central Coast regional water quality guidelines based on the 20th and 80th percentiles of test site data

[b] Mixture of all bed habitats within the site (e.g. sandy pool, rocky pool, riffle, run, cascade)

SIGNAL 2 scores can be interpreted in conjunction with the number of families found in the sample. This is achieved using a SIGNAL 2 / family bi-plot (Chessman 2003). The plots are divided into quadrants, with each quadrant indicative of environmental conditions that may influence a community (Figure 2.3). Quadrant boundaries for the SIGNAL 2 / family bi-plot used for this assessment are based on the upper (80th percentile) biological guideline values for taxonomic richness and SIGNAL scores.

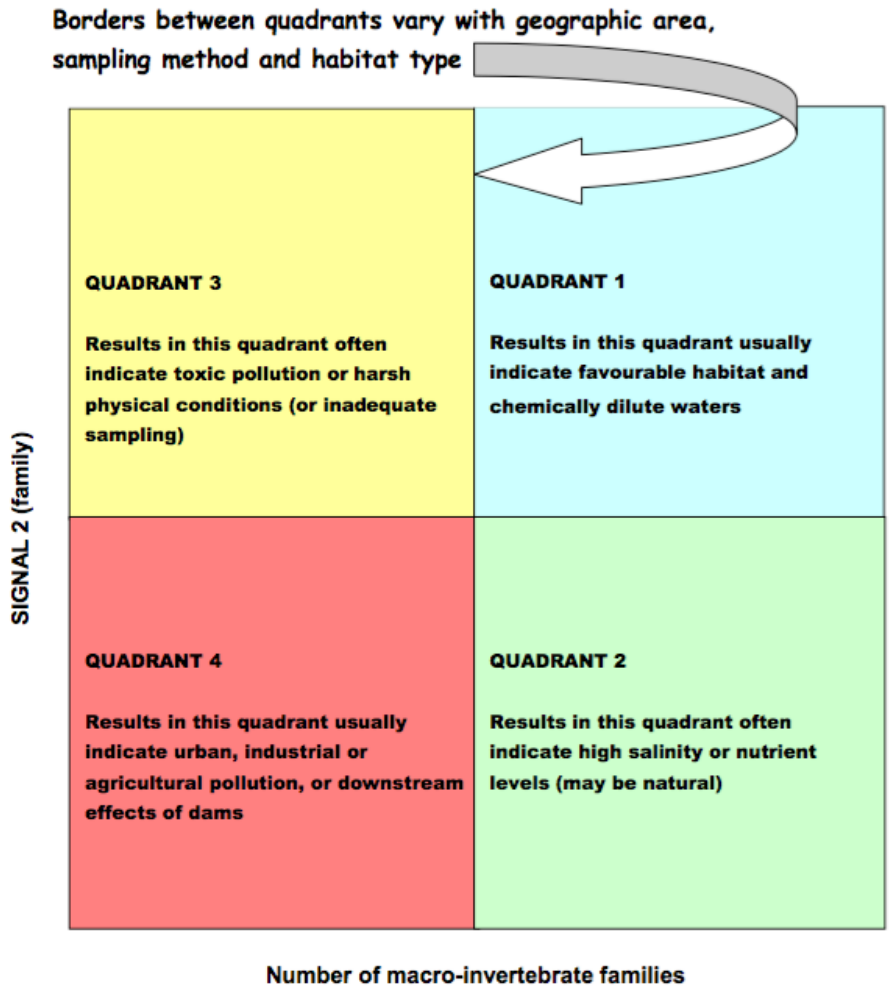


Figure 2.3 Quadrant diagram for SIGNAL2 / family bi-plot (Chessman 2003)

2.1.2.8 Aquatic Vertebrates

Fish

At each comprehensive aquatic ecology site that held sufficient water (Table 2.3), fish communities were surveyed using a combination of methods depending on the habitat characteristics of the site, including backpack electrofisher (BPEF), fyke nets and baited traps. Survey methods and effort used at each site during each survey are summarised in Table 2.7.

Table 2.7 Fish and turtle survey effort at each site in each survey

Location	Site	Method	No.	Date / Time In	Date / Time Out	Total Effort (net soak)
May 2019						
Upstream of Project area	I1	BPEF	–	13:30, 16/5/2019	14:10, 16/5/2019	700s at 400V, 30% DC, 80Hz
Adjacent to Project area	RCT4	BPEF	–	14:00, 20/5/2019	14:25, 20/5/2019	400s at 400V, 30% DC, 80Hz
Within Project area	FD2	Fyke	2	16:00, 16/5/2019	9:15, 17/5/2019	34.5 hours net soak time
		Baited box traps	5	16:00, 16/5/2019	9:15, 17/5/2019	86.25 hours net soak time
	U4	BPEF	–	10:00, 20/5/2019	10:30, 20/5/2019	500s at 250V, 40% DC, 80Hz
Downstream of Project area	I2a	BPEF	–	11:15, 19/5/2019	12:00, 19/5/2019	900s at 430V, 70% DC, 80Hz
	I3	Fyke	2	15:30, 19/5/2019	9:30, 20/5/2019	36 hours net soak time
		Baited box traps	5	15:30, 19/5/2019	9:45, 20/5/2019	91.25 hours net soak time
	U1	BPEF	–	10:30, 16/5/2019	11:05, 16/5/2019	618s at 470V, 30% DC, 90Hz
October 2019						
Within Project area	FD2	Fyke	2	16:00, 18/10/2019	8:30, 19/10/2019	33 hours net soak time
		Baited box traps	5	15:30, 18/10/2019	9:00, 19/10/2019	87.5 hours net soak time
	FD4	Fyke	3	16:45, 15/10/2019	8:30, 16/10/2019	47.25 hours net soak time
		Baited box traps	5	16:00, 15/10/2019	9:00, 16/10/2019	85 hours net soak time
Adjacent to Project area	FD6	Fyke	3	14:30, 16/10/2019	9:00, 17/10/2019	55.5 hours net soak time
		Baited box traps	5	14:30, 16/10/2019	9:00, 17/10/2019	92.5 hours net soak time
Downstream of Project area	I1a	Fyke	2	15:30, 19/10/2019	10:00, 20/10/2019	37 hours net soak time
		Baited box traps	5	15:30, 19/10/2019	9:30, 20/10/2019	90 hours net soak time

All sampling was completed in accordance with the techniques and methodologies appropriate to the conditions at each site, as outlined in the latest version of the *Monitoring and Sampling Manual: Environmental Protection (Water) Policy 2009* (DES 2018a), the *Australian Code of Electrofishing Practice* (Standing Committee for Fisheries and Aquaculture 1997), and the *Survey Guidelines for Australia's Threatened Fish* (Department of Sustainability, Environment, Water, Population and Communities [SEWPaC] 2011a); and relevant permits issued to ESP, including General Fisheries Permit 193593, Animal Ethics Approval CA 2017/06/1072 and Scientific Purposes Permit WISP14986614 (in May 2019) / WA0017831 (in October 2019). These methods were considered sufficient for recording the listed threatened fish species that may occur in the broader region (i.e. silver perch, *Bidyanus bidyanus;* and Murray cod, *Maccullochella peelii*) if present within the waterways in the vicinity of the Project. Specifically, both fyke netting and electrofishing are considered suitable methods for detecting these species (SEWPaC 2011a); though it should be noted that these species were considered unlikely to occur based on findings of the desktop review, the habitat present within the Study area (i.e. lack of large deep pools), and the results of the baseline field surveys (Sections 3.6 & 3.7).

All native fish were identified, counted, and returned to the environment. The total length (cm) of fish, of a subsample of 20 individuals per species caught at each site, was measured. Pest fish were identified, counted and euthanized in accordance with permit conditions.

The abundance of fish species caught at each site was calculated and tabulated. Life history stages of native fish were determined using length measurements (based on information in Pusey et al. 2004), graphed and discussed.

Turtles

Turtles were surveyed at comprehensive aquatic ecology sites that contained suitable potential habitat (Table 2.3). Turtles were surveyed in conjunction with fish surveys (i.e. fyke nets set for fish surveys were set to trap turtles also). Survey effort used at each site during each survey is summarised in Table 2.7.

All sampling was completed in accordance with the trapping methodology outlined in the *Terrestrial Vertebrate Fauna Survey Guidelines for Queensland* (Eyre et. al 2018) as well as relevant permits issued to ESP, including Animal Ethics Approval CA 2017/06/1072 and Scientific Purposes Permit WISP14986614 (in May 2019) / WA0017831 (in October 2019).

Once caught, turtles were identified and returned back to the environment. Observations of suitable habitat for turtles (including nesting habitat) were also noted.

As no potential habitat for listed threatened turtle species known from the broader region (i.e. Fitzroy River turtle, *Rheodytes leukops;* white-throated snapping turtle, *Elseya albagula*) was recorded and they are considered unlikely to occur based on findings of the desktop review (including a review of the location of known records), a lack of suitable habitat for these species in the Study area (i.e. lack of large deep pools associated with riffles) and the results of the baseline field surveys, further surveys for these species using other techniques such as snorkelling or spotlighting, as outlined in the *Terrestrial Vertebrate Fauna Survey Guidelines for Queensland* (Eyre et. al 2018) and *Survey Guidelines for Australia's Threatened Reptiles* (SEWPaC 2011b), were not completed.

Platypus

Visual observations for habitat features preferred by platypus (*Ornithorhynchus anatinus*) or their potential presence were completed at each site, including:

- presence of permanent pools (not deeper than 5 m) with runs and riffles,
- a diversity of instream features to refuge amongst (e.g. submerged aquatic vegetation, submerged rock crevices, undercut banks and/or submerged logs and fallen trees),
- presence of platypus burrows along the banks, and
- relatively steep earth banks well-consolidated by riparian vegetation and with growth overhanging the bank (Scott and Grant 1997).

As no suitable platypus habitat or burrows were noted at any of the survey sites, targeted platypus surveys were not completed as part of this assessment.

2.2 Stygofauna Assessment

Stygofauna are subterranean aquatic fauna that live part of or all of their lives in groundwater systems (DES 2018b). A desktop review and pilot survey for stygofauna in accordance with the *Guideline for the Environmental Assessment of Subterranean Aquatic Fauna* (DES 2015) and the *Information Guidelines Explanatory Note: Assessing groundwater-dependent ecosystems* (Doody et al. 2019), was conducted to:

- assess the suitability of local habitat for stygofauna based on the hydrogeology in the vicinity of the Project,
- assess the likely presence and composition of stygofauna in the vicinity of the Project, and
- assess the impact of the Project on subterranean aquatic fauna.

2.2.1 Desktop Review

A comprehensive desktop review was completed to describe the relevant information available on stygofauna and the groundwater environment, including:

- the *Queensland Subterranean Aquatic Fauna Database* curated by the Qld Herbarium (State of Queensland 2020),
- bore records provided by Oasis Hydrology Pty Ltd (pers. comm. 2019),
- scientific publications regarding the habitat preferences and distribution of stygofauna, including the CSIRO report to the Australian Coal Association Research Program on the extent of knowledge of stygofauna in Australian groundwater systems (Hose et al. 2015),
- stygofauna studies previously completed in the vicinity of the Project, including baseline assessments for the adjacent Olive Downs Project EIS (DPM Enviros ciences 2018) and nearby Isaac Downs Project (frc environmental 2019) and Vulcan Complex Project (frc environmental 2020),

- geology mapping (URS 2009).

The desktop review was informed by the Groundwater Assessment (SLR 2021).

2.2.2 Field Surveys

Sampling for stygofauna was undertaken in May and October 2019, and January 2020 as per the *Guideline for the Environmental Assessment of Subterranean Aquatic Fauna* (DES 2015). Sampling was completed at eleven bores, distributed throughout the Project area and comparable nearby bores outside of the Project area (Map 8). Each bore was established at least six months prior to stygofauna sampling and contained groundwater. in-situ water quality measurements for EC and pH were also taken at each bore, to aid in the interpretation of results.

2.2.2.1 Bore Locations and Survey Timing

A total of eleven bores were sampled as part of the stygofauna assessment with sampling completed in conjunction with the aquatic ecology surveys; seven bores were sampled during the late-wet season in May 2019, and an additional two bores were sampled during the early-wet season in October 2019. Sampling was then completed at eleven bores in January 2020, including the nine bores sampled in May and October 2019, and an additional two bores (i.e. Knob Hill 1 and R2008) which were physically obstructed in May and October 2019 (and as such the sampling net was not able to be lowered to the bottom of the bores), but were able to be sampled using different equipment in January 2020 (by using the pumping method instead of nets).

The locations of the bores sampled are described in Table 2.8 and displayed on Map 8.

Table 2.8 Bore sampling sites surveyed in May and October 2019, and January 2020

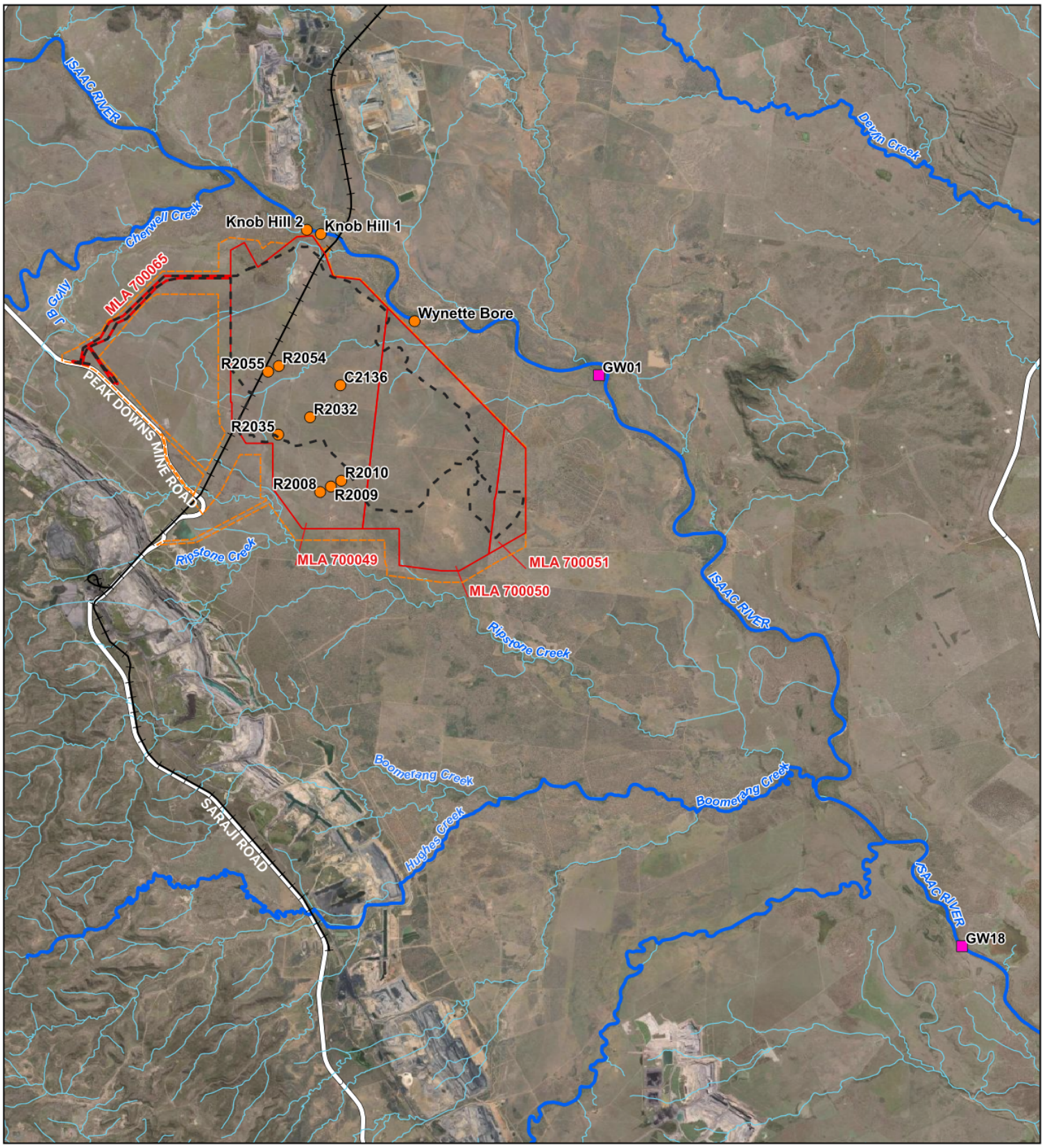
Bore	Latitude	Longitude	Total Depth (mbGL)	May-19	Oct-19	Jan-20
Wynette Bore	-22.1497	148.3071	18.6[a]	–	Y	Y
Knob Hill 2	-22.1136	148.2645	23.4[a]	–	Y	Y
C2136	-22.1750	148.2778	65.6	Y	–	Y
R2009	-22.2151	148.2740	81.0	Y	–	Y
R2010	-22.2128	148.2782	64.5	Y	–	Y
R2032	-22.1877	148.2658	81.1	Y	–	Y
R2035	-22.1946	148.2532	37.4	Y	–	Y
R2054	-22.1674	148.2535	82.5	Y	–	Y
R2055	-22.1697	148.2492	67.9	Y	–	Y
Knob Hill 1	-22.1152	148.2701	20.0[a]	–	–	Y
R2008	-22.2173	148.2698	33.0	–	–	Y

mbGL = metres below ground level

– not sampled

Y sampled

[a] field estimate, data not available



Legend

- Indicative surface disturbance extent
- Winchester South MLA
- Primary study area
- Sampled bores
- Sampled bores (Olive Downs EIS)
- Railway
- Road

Waterways and Wetlands*

- Waterway - major
- Waterway - minor

* as per Government mapping and not ground-truthed

Map 8: Location of bores sampled for the stygofauna assessment

Project Number: 1845
Author: JK
Date: 02 November 2020
Datum: GDA94
Data Sources:
© DNRME 2020; DPM 2018 DTMR 2020; Esri 2020

0 1 2 3 4 km

2.2.2.2 Water Quality

Water quality (conductivity and pH) was measured in-situ at each bore using a hand-held YSI ProDSS multi-parameter water quality sonde. In May and October 2019, a bailer was used to collect a water sample from approximately 1-2 m below the water level of the bore. The sample was retrieved slowly and poured into the measuring cup of the water quality probe. The water sample was collected before the stygofauna samples were collected. In January 2020, water quality was measured using water pumped from the bore.

The water quality meter was calibrated prior to field sampling.

2.2.2.3 Stygofauna Sampling

In May and October 2019, the full water column within each bore was sampled by hauling a weighted phraetobiological net. Three hauls were completed with a fine mesh net (50 micrometres [µm]), and three hauls were completed with a coarse mesh net (150 µm). Nets were lowered to the bottom of the bore, bounced five times to dislodge resting animals and then carefully retrieved. After each haul, the net and collection vial were emptied onto a 50 µm sieve and rinsed with deionised water. The three fine mesh hauls and three coarse net hauls were combined into one sample per bore and preserved in 100% ethanol. Nets were rinsed thoroughly with deionised water between survey bores.

In January 2020, most bores were sampled using a pump. The exceptions were R2009, R2032 and R2035 which did not contain sufficient water for pumping and were therefore sampled using nets (as per the methods used in May and October 2019, as outlined above). The pump hose was lowered into the bore and water was pumped into buckets. The total volume of water sampled at each bore varied depending on the depth of the bore and water level and the rate of bore recharge, but in all cases was at least two times the volume of the bore (and in most cases > 200 litres). The contents of each bucket were gently swirled to suspend any organic matter and sediment, and then poured through a 50 µm mesh sieve. The contents of the sieve were then transferred into sample jars and preserved in 100% ethanol.

Photographs were taken of the bore and surrounding environment during all surveys. The diameter of the bore, casing type, whether the bore was screened and whether a pump was installed, the height of the collar and the depth of the bore and depth to water level were also recorded.

The methods and equipment used to sample stygofauna complied with standards in accordance with the *Guideline for the Environmental Assessment of Subterranean Aquatic Fauna* (DES 2015).

2.2.2.4 Sample Processing

The stygofauna samples were sorted in the laboratory under a stereomicroscope. Each sample container was drained of ethanol and washed into a shallow elongated counting tray to create a thin layer of sediment spread across the bottom of the tray. Any animals were transferred into 2 millilitres vials with 100% ethanol and identified to the lowest practical taxonomic level.

All field work and processing was undertaken by suitably qualified ecologists. No stygofauna specimens were found, but all terrestrial specimens were identified to the lowest possible taxonomic level in ESP's macroinvertebrate laboratory. Advice was sought from Peter Hancock (Eco Logical Australia) regarding the identification of oligochaete specimens that were recorded from one bore in October 2019, and to confirm that mites (Acarina) recorded in January 2020 were terrestrial specimens.

3 Aquatic Ecology Results

3.1 Aquatic Habitat

3.1.1 Lacustrine Wetlands and Farm Dams

Several State mapped lacustrine wetlands (wetlands associated with lakes) are mapped in the vicinity of the Project (Map 9), five of which were assessed during the field surveys, including:

- one site approximately 8 km west of the Project area (i.e. site LW4),
- three sites within the Project area (i.e. sites LW1, LW2 and LW3), and
- one site approximately 2.5 km downstream of the Project area (i.e. site LW5).

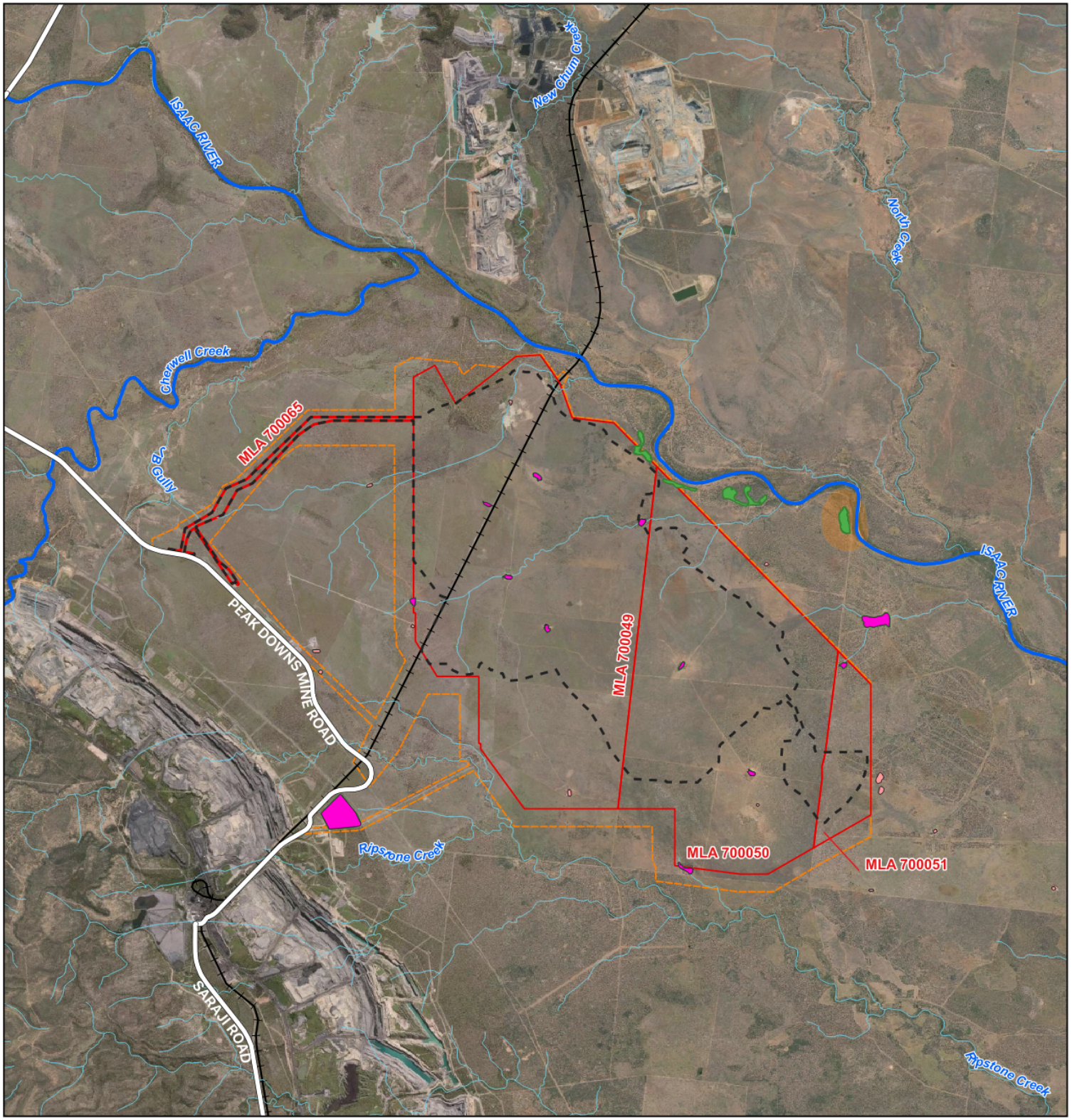
All of these lacustrine wetlands were characterised as man-made dams, either for agriculture / stock watering (farm dams at sites LW1, LW2, LW3 and LW5) or mine water management (site LW4) (Map 9).

Consistent with the farm dam mapping completed by E2M Pty Ltd (E2M) (2021), and ground-truthing completed by ESP, there were also a number of unmapped farm dams within the study area, seven of which were surveyed (Map 9), including:

- one site west of the Project area (i.e. site FD1),
- two sites within the Project area (i.e. sites FD2 and FD4),
- one site immediately downstream of the north-eastern boundary of the Project area (i.e. site FD3),
- one site approximately 1.25 km south of the Project area (i.e. site FD5),
- one site approximately 2.5 km south of the Project area (i.e. site FD6), and
- one site approximately 1 km downstream of the Project area (i.e. site FD7).

A detailed description of aquatic habitat condition at these sites is presented in Appendix C. The field assessment confirmed that the State mapped wetlands meet the definition of a wetland under the *Queensland Wetland Definition and Delineation Guideline – Part A: A Guide to Existing Wetland Definitions and the Application of the Queensland Wetlands Program Definition* (DERM 2010), which includes artificial wetlands. The field assessment also confirmed that the unmapped farm dams meet the definition of a lacustrine wetland in accordance with the Queensland Wetland Definition and Delineation Guideline (DERM 2010). This is because, while these are constructed farm dams, they meet the Queensland Wetland Program wetland definition as they:

- are areas of permanent or periodic/intermittent inundation with freshwater that is static,
- support, at least periodically, plants and animals adapted to and dependent on living in wet conditions for at least part of their life cycle (including aquatic plants, fish and turtles, refer Sections 3.4 – 3.6), and
- the substratum is predominately undrained soils.



Legend

- Indicative surface disturbance extent
- Winchester South MLA
- Primary study Area
- Road
- Railway
- Ground-truthed wetlands
- Ground-truthed dams
- E2M Ground-truthed dams

Waterways and Wetlands*

- Waterway - major
- Waterway - minor

*as per Government mapping and not ground-truthed

Map 9: Ground-truthed wetlands and farm dams in the vicinity of the Winchester South Project

Project Number: 1845
Author: JK
Date: 02 November 2020
Datum: GDA94
Data Sources:
© DES 2020; DNRME 2020; DTMR 2020; Esri 2020, E2M 2020

0 1 2 3 4 km

Aquatic habitat at mapped lacustrine wetlands (DES 2020d) and farm dams not mapped by DES was relatively similar and consisted of shallow and deep pools with some terrestrial woody debris and detritus. Instream sediments were typically dominated by blanketing fine silt / clay. The water level was low at most sites, particularly during October 2019, resulting in poor canopy cover and instream shading from riparian vegetation and limited trailing and overhanging vegetation. Some sites contained abundant and diverse aquatic plant communities, including floating and submerged species, indicating that they hold water for extended periods and provide relatively favourable conditions for aquatic flora (Figure 3.1). Most sites were highly impacted by cattle access, resulting in extensive vegetation clearing of the riparian zone, eroded banks and trampling (Figure 3.2).

Although connectivity to downstream habitats was typically limited due to the construction of dam walls, most of these sites (except for sites LW1 and LW2) contained water during the October 2019 survey, and would therefore provide dry season refuges for aquatic flora and fauna.

Figure 3.1 Diverse and abundant aquatic plant communities at farm dam site LW5 in October 2019

Figure 3.2 High levels of vegetation clearing and disturbance from cattle access at farm dam site FD7 in October 2019

3.1.2 Palustrine Wetlands

There are several mapped palustrine wetlands (DES 2020d) in the vicinity of the Project, four of which were assessed during the field surveys (sites PW1 to PW4). One of these wetlands (site PW1) is mapped as a HES wetland and is discussed in more detail in Section 3.1.2.1 below.

All mapped palustrine wetlands were dry in May and October 2019. They are located adjacent to the Isaac River in the floodplain, and would likely become inundated infrequently during periods of high rainfall and flooding. Although the wetlands did not hold water in May 2019 (i.e. the late-wet season surveys), they contained emergent wetland indicator plant species and had features indicative of previously wet conditions (e.g. depressions indicating ponding, recently dried mud), showing that they contain water periodically. The field assessment confirmed that the State mapped palustrine wetlands meet the definition of a wetland under the *Queensland Wetland Definition and Delineation Guideline – Part A: A Guide to Existing Wetland Definitions and the Application of the Queensland Wetlands Program Definition* (DERM 2010). The ground-truthed boundaries of the wetlands broadly aligned with the State mapping (DES 2020d) (Map 9).

The dry beds contained several potential habitat features for aquatic fauna, including trailing and overhanging vegetation, a variety of woody debris and terrestrial detritus. The riparian zones were typically in good condition and consisted of semi-continuous bands of mature trees, shrubs and grasses, though vegetation clearing had occurred in the broader area for cattle grazing and access tracks. In May 2019, the dry beds were filled with an abundance of emergent aquatic plants (Figure 3.3). However, most of these aquatic plants had died off in the October 2019 survey due to the dry conditions. All of the palustrine wetlands were slightly to moderately disturbed by cattle access and trampling, and some contained a low abundance of terrestrial weed species.

E2M (2021) has mapped an area of ground-truthed regional ecosystem (RE) 11.3.3c in the Project area (within MLA 700049). This RE community is described as *Eucalyptus coolabah woodland to open woodland (to scattered trees) with a sedge or grass understorey* and as a palustrine wetland in the regional ecosystem description (DES 2019). This area is not mapped as a palustrine wetland by the State (DES 2020d). In accordance with the *Queensland Wetland Definition and Delineation Guidelines – Part A: A Guide to Existing Wetland Definitions and the Application of the Queensland Wetlands Program Definition* (DERM, 2010a), this area of RE 11.3.3c is considered to technically meet the definition of a wetland given the following:

- four wetland indicator species were present in the understorey (*Echinochloa colona*, *Eclipta prostrata*, *Eleocharis* sp. and *Leptochloa digitata*),
- the species composition is similar to that of the ground-truthed palustrine wetlands described above, and
- there is evidence of periodic inundation of this area based on historical aerial photography (Queensland Government 2020).

As such, it is considered that this area is likely to be representative of a palustrine wetland RE. The biodiversity values of this patch are considered to be largely terrestrial (i.e. provide limited aquatic values) due to the highly ephemeral nature of the inundation and the distance from the Isaac River, which would limit the aquatic connectivity of this wetland RE.

Palustrine wetlands were not formally assessed by frc environmental during baseline surveys in 2012, though a brief inspection was completed by frc environmental at the HES wetland (see Section 3.1.2.1 below).

Figure 3.3 Abundant emergent aquatic plant communities in the dry bed at site PW2 in May 2019

3.1.2.1 Mapped High Ecological Significance Wetlands

HES Wetlands are wetlands that have been assigned a “high” conservation value according to the AquaBAMM assessments, which were based primarily on a desktop review, and no field surveys (Rollason & Howell 2012). The “high” conservation value for the HES wetland 4 km to the east (and 5 km downstream) of the Project area (i.e. site PW1, Map 6), which is also a WPA, was based on (Queensland Government 2020):

- a very high score for the ‘naturalness’ criteria,
- a medium score for the ‘diversity and richness’ criteria,
- a high score for the ‘threatened species and ecosystems’ criteria,
- a high score for the ‘priority species and ecosystems’ criteria, and
- a high score for the ‘representativeness’ criteria.

Similar to the other mapped palustrine wetlands assessed during the field surveys, this site was dry in May and October 2019. Previous assessments of this wetland concluded that the ecological values were largely terrestrial rather than aquatic, with limited aquatic habitat present (frc environmental 2012). The current field assessment confirmed this assessment. Evidence of previous inundation (likely associated with the large rainfall event that occurred in March 2019) was noted.

Although it did not contain water at the time of the current or previous aquatic ecology surveys, the State mapped palustrine HES wetland meets the definition of a wetland under the *Queensland Wetland Definition and Delineation Guideline – Part A: A Guide to Existing Wetland Definitions and the Application of the Queensland Wetlands Program Definition* (DERM 2010). The ground-truthed boundary of the wetland broadly aligned with the State mapping (DES 2020d) (Map 9).

The dry bed contained several potential habitat features, including trailing and overhanging vegetation, a variety of woody debris and terrestrial detritus. The riparian zone consisted of a semi-continuous band of mature trees, shrubs and grasses, though vegetation clearing had occurred in the broader area for cattle grazing. There were some terrestrial weeds growing in the dry bed, but otherwise disturbance was relatively low. In May 2019, the dry beds were filled with an abundance of emergent aquatic plants (Figure 3.4). However, most of these aquatic plants had died off in the October 2019 survey due to the dry conditions.

Although mapped as an HES wetland, field surveys concluded that aquatic habitat condition of this site was similar to other mapped palustrine wetlands in the Study area. Based on aquatic habitat observations made during the field assessment this wetland was considered to have (from an aquatic ecological perspective):

- a very high score for the 'naturalness' criteria,
- a medium score for the 'diversity and richness' criteria,
- a low score for the 'threatened species and ecosystems' criteria (the HES wetland does not provide suitable habitat for any threatened aquatic species or ecosystems),
- a low score for the 'priority species and ecosystems' criteria (the HES wetland does not provide suitable habitat for any priority aquatic species or ecosystems), and
- a high score for the 'representativeness' criteria.

Figure 3.4 Good riparian coverage and emergent aquatic plants at site PW1 (HES wetland) in May 2019

3.1.3 Waterways

Aquatic habitat condition was fairly consistent across sites located on waterways, with poor to fair conditions in the minor (low Strahler stream-order) waterways (i.e. unnamed tributaries of Ripstone Creek and the Isaac River) but better conditions in the major (higher stream order) waterways (i.e. Cherwell Creek, Ripstone Creek and the Isaac River) (Figure 3.5). Sites that contained water were characterised by pool habitat that would typically persist intermittently following high rainfall events (Figure 3.6); other sites were characteristic of highly ephemeral waterways that channel water and potentially provide for aquatic fauna passage during periods of high rainfall, but do not hold significant pools for extended periods (Figure 3.7). The exception was site I1a on the Isaac River downstream of the Project, which contained a pool in October 2019, suggesting that this pool may persist for the majority of the year (or all year when wet season rainfall is average or above-average) as a dry season refuge.

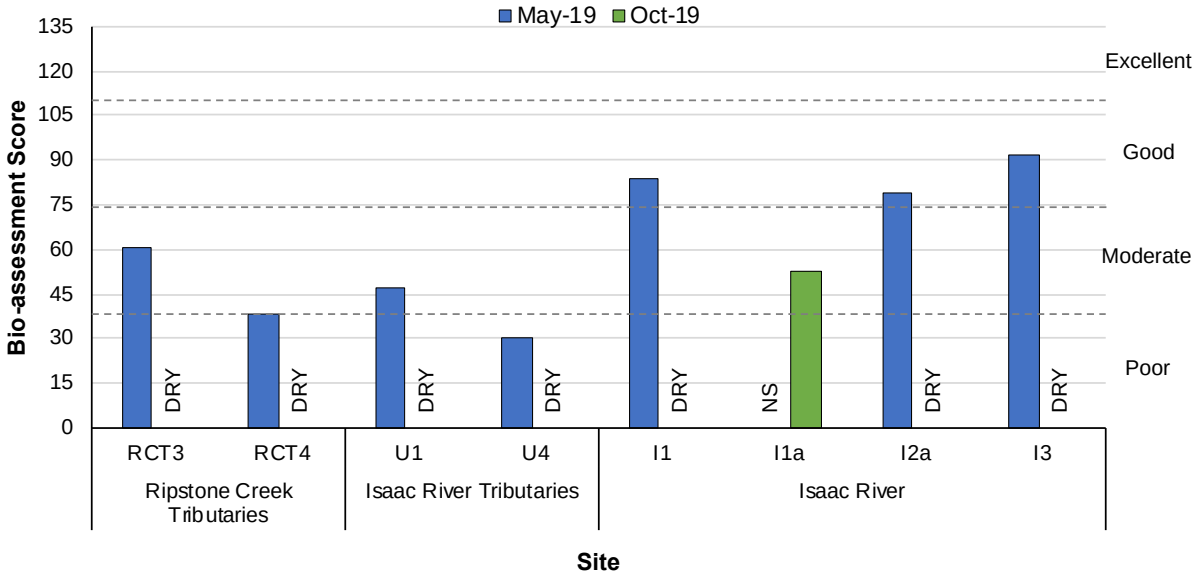


Figure 3.5 Bioassessment scores at wet waterway sites in May 2019 and October 2019 (NS denotes site was not surveyed)

Figure 3.6 Isolated pool habitat at site I3 (Isaac River) in May 2019

Figure 3.7 Dry, ephemeral channel at site U1 (unnamed tributary of the Isaac River in the north of the Project area) in October 2019

In minor waterways, such as unnamed tributaries of Ripstone Creek and the Isaac River, in-stream features were limited. Habitat was characterised by shallow pools (at wet sites), moderate to extensive build-up of instream siltation by fine sediments, limited in-stream and bankside vegetation, moderate to high disturbances to bed and bank stability as a result of cattle access, and reduced and limited riparian vegetation as a result of land clearing associated with the adjacent land uses.

In major waterways, such as Cherwell Creek, Ripstone Creek and the Isaac River, in-stream features were more abundant with shallow and deep pools (at wet sites), variable substrate (dominated by sand but with larger substrate types present in low abundance), in-stream woody debris and moderate to high coverage of trailing and overhanging bankside vegetation. Bed and bank stability were low to moderately disturbed from cattle access and high flows. Although riparian vegetation was reduced as a result of land clearing associated with the adjacent land uses, the banks remained well vegetated by predominantly mature native trees (namely *Eucalyptus* spp., *Casuarina* spp., *Acacia* spp. and *Melaleuca* spp.) with a sparse to moderate groundcover of grasses.

3.2 Water Quality

3.2.1 Environmental Values

The quality of natural waters in Qld is protected under the EPP (Water and Wetland Biodiversity). The purpose of the EPP (Water and Wetland Biodiversity) is to achieve the objectives of the EP Act in relation to waters and wetlands.

The EPP (Water and Wetland Biodiversity) outlines the Environmental Values (EVs) that may apply to waters in Qld, and for ecological values describe various levels of protection for high ecological value (HEV), slightly disturbed, moderately disturbed and highly disturbed waters as well as associated WQOs.

Water quality in the vicinity of the Project was in moderate to good condition, likely influenced to some degree by surrounding land-use and local geomorphology, which is characteristic of a moderately disturbed ecosystem. Surface water of waterways and wetlands within the vicinity of the Project was highly variable, as is typical of ephemeral systems in the region, and was characterised by (Table 3.1):

- neutral to slightly alkaline pH,
- variable EC (low at waterway sites and high at most farm dam sites),
- well saturated dissolved oxygen levels, although percent saturation in small drying pools (i.e. site U1 in May 2019 and site I1a in October 2019) was low, as is expected in remnant pools,
- variable turbidity,
- low concentrations of ions,
- high concentrations of nutrients, and
- low concentrations of most metals, with concentrations of most dissolved metals at most sites less than the laboratory limit of reporting (<LOR); except for copper, uranium and vanadium which had high concentrations some sites in both surveys.

3.3 Sediment Quality

Sediment quality of waterways and wetlands in the vicinity of the Project was in moderate condition and likely influenced to some degree by surrounding land-use and local geomorphology, which is characteristic of a moderately disturbed ecosystem.

In May and October 2019, sediments were characterised by a variety of metals and metalloids, including the following which were commonly detected in samples at all or most sites: aluminium; chromium; iron; manganese; nickel; vanadium; barium; cobalt; copper; lead; uranium and zinc. Several metals and metalloids were not detected at all (i.e. concentrations were <LOR), including: boron; cadmium; mercury; molybdenum; selenium; and silver; as well as BTEXN chemicals (Table 3.2 and Table 3.3).

Concentrations of most parameters were below the DGVs except for nickel, which was above the DGV at a number of sites in both surveys and petroleum hydrocarbons, which were above the GV-high value at site PW1 (HES palustrine wetland downstream of the Project) in both surveys and the DGV at site I1a (Isaac River downstream of the Project) in October 2019 (Table 3.2 and Table 3.3).

Table 3.1 Water quality at sites sampled during aquatic ecology surveys completed in May 2019 and October 2019

Parameter	Unit	May 2019								October 2019		
		Ripstone Creek Tributaries	Isaac River Tributaries		Isaac River			Farm Dams	Isaac River	Farm Dams		
		RCT4	U1	U4	I1	I2a	I3	FD2	I1a	FD2	FD4	FD6
Physical												
Temperature	°C	24	20.7	23.5	23.1	21.2	24.9	20.3	26.9	26.4	27.5	30
pH	pH	8.2	7.6	7.9	8.3	8.0	7.6	8.1	7.9	9.8	8.4	8.6
EC	µS/cm	307	223	406	320	365	270	309	708	319	654	231
Dissolved oxygen	%Sat	133	83	102	114	97	98	94	62	112	104	117
Turbidity	NTU	114	33	149	7	14	32	15	45	62	50	9
TDS	mg/L	234	168	261	185	207	151	185	401	207	425	166
TSS	mg/L	46	20	186	<LOR	<LOR	26	<LOR	51	26	17	6
Major ions												
Total hardness	mg/L	125	67	141	104	103	73	82	189	60	140	78
Sulfate	mg/L	4	3	1	6	6	4	2	2	3	4	<LOR
Calcium	mg/L	37	17	40	25	23	16	18	33	9	20	18
Magnesium	mg/L	8	6	10	10	11	8	9	26	9	22	8
Sodium	mg/L	11	19	32	27	33	26	37	66	46	89	14
Potassium	mg/L	13	6	6	3	5	4	6	13	6	15	8
Fluoride	mg/L	0.3	0.3	0.5	0.2	0.2	0.2	0.8	0.3	0.9	0.6	0.2
Nutrients												
Ammonia	µg/L	20	20	20	30	30	20	20	40	30	40	<LOR
Nitrite	µg/L	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Nitrate	µg/L	410	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	150	<LOR	<LOR
Oxides of nitrogen	µg/L	410	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	150	<LOR	<LOR
TKN	µg/L	1300	800	2100	200	200	400	300	2600	800	2100	900
Organic nitrogen	µg/L	1280	780	2080	170	170	380	280	2560	770	2060	900

Parameter	Unit	May 2019							October 2019			
		Ripstone Creek Tributaries	Isaac River Tributaries		Isaac River			Farm Dams	Isaac River	Farm Dams		
		RCT4	U1	U4	I1	I2a	I3	FD2	I1a	FD2	FD4	FD6
Total nitrogen	µg/L	1700	800	2100	200	200	400	300	2600	1000	2100	900
FRP	µg/L	<LOR	<LOR	30	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Total phosphorus	µg/L	120	60	290	<LOR	<LOR	40	<LOR	150	20	60	30
Total Metals and Metalloids												
Aluminium	µg/L	5740	1350	11100	190	260	730	570	530	2330	940	150
Arsenic	µg/L	2	2	2	1	<LOR	1	<LOR	2	2	1	2
Boron	µg/L	60	<LOR	100	<LOR	<LOR	<LOR	110	140	180	360	80
Cadmium	µg/L	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Chromium	µg/L	8	2	9	<LOR	<LOR	<LOR	<LOR	<LOR	4	<LOR	<LOR
Cobalt	µg/L	3	<LOR	5	<LOR	<LOR	1	<LOR	2	1	<LOR	<LOR
Copper	µg/L	8	2	13	<LOR	<LOR	1	2	1	5	2	<LOR
Iron	µg/L	4740	1400	8200	140	200	1210	420	2010	1740	950	260
Lead	µg/L	2	<LOR	3	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Manganese	µg/L	165	28	237	48	21	215	20	893	82	117	188
Mercury	µg/L	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Molybdenum	µg/L	1	1	1	1	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	1
Nickel	µg/L	8	4	10	2	1	2	1	4	4	2	3
Selenium	µg/L	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Silver	µg/L	<LOR	<LOR	0.03	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Uranium	µg/L	<LOR	<LOR	3	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	2	<LOR
Vanadium	µg/L	20	<LOR	30	<LOR	<LOR	<LOR	<LOR	<LOR	20	<LOR	<LOR
Zinc	µg/L	6	<LOR	17	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR

Parameter	Unit	May 2019							October 2019			
		Ripstone Creek Tributaries	Isaac River Tributaries		Isaac River			Farm Dams	Isaac River	Farm Dams		
		RCT4	U1	U4	I1	I2a	I3	FD2	I1a	FD2	FD4	FD6
Dissolved Metals and Metalloids												
Aluminium	µg/L	<LOR	10	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Arsenic	µg/L	<LOR	1	1	<LOR	<LOR	<LOR	<LOR	2	2	1	2
Boron	µg/L	70	60	110	60	50	60	140	130	160	270	70
Cadmium	µg/L	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Chromium	µg/L	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Cobalt	µg/L	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Copper	µg/L	4	2	5	<LOR	<LOR	<LOR	1	<LOR	2	2	<LOR
Iron	µg/L	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Lead	µg/L	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Manganese	µg/L	3	4	45	6	3	11	<LOR	559	2	4	5
Mercury	µg/L	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Molybdenum	µg/L	1	1	2	1	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Nickel	µg/L	2	2	3	1	1	1	<LOR	3	<LOR	1	3
Selenium	µg/L	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Silver	µg/L	<LOR	<LOR	<LOR	0.02	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Uranium	µg/L	<LOR	<LOR	3	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	2	<LOR
Vanadium	µg/L	10	<LOR	10	<LOR	<LOR	<LOR	<LOR	<LOR	10	<LOR	<LOR
Zinc	µg/L	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Petroleum Hydrocarbon Fractions												
C6 - C9	µg/L	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
C10 - C14	µg/L	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
C15 - C28	µg/L	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	200	<LOR	<LOR	<LOR
C29 - C36	µg/L	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
C10 - C36 (sum)	µg/L	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	200	<LOR	<LOR	<LOR

Parameter	Unit	May 2019							October 2019			
		Ripstone Creek Tributaries	Isaac River Tributaries		Isaac River			Farm Dams	Isaac River	Farm Dams		
		RCT4	U1	U4	I1	I2a	I3	FD2	I1a	FD2	FD4	FD6
BTEXN												
Sum of BTEX	µg/L	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Naphthalene	µg/L	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR

grey shading denotes values that are above the relevant WQO / WQO range (Table 2.4)
blue shading denotes values that are below the relevant WQO range (Table 2.4)
<LOR result less than the laboratory limit of reporting

Table 3.2 Sediment quality at sites sampled during aquatic ecology surveys completed in May 2019

Parameter	Unit	Ripstone Creek Tributaries	Ripstone Creek	Isaac River Tributaries				Isaac River			Farm Dams	Palustrine Wetlands	
		RCT4	RC1	U1	U2	U3	U4	I1	I2a	I3	FD2	PW1	PW4
Metals and Metalloids													
Aluminium	mg/kg	17000	1280	4360	10800	13300	13000	3730	1340	760	9470	5310	8160
Arsenic	mg/kg	5	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	6	<LOR	<LOR
Barium	mg/kg	390	50	80	540	440	330	70	20	10	320	140	200
Beryllium	mg/kg	1	<LOR	<LOR	<LOR	1	1	<LOR	<LOR	<LOR	<LOR	<LOR	1
Boron	mg/kg	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Cadmium	mg/kg	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Chromium	mg/kg	41	11	12	14	24	24	12	6	6	44	17	21
Cobalt	mg/kg	17	4	8	18	18	23	6	2	<LOR	15	6	11
Copper	mg/kg	29	<LOR	8	31	20	22	8	<LOR	<LOR	22	13	24
Iron	mg/kg	30000	16000	14500	24500	19100	30100	11800	5290	3660	26000	13900	18200
Lead	mg/kg	14	10	10	22	18	26	6	<LOR	<LOR	15	10	16
Manganese	mg/kg	1120	201	210	1920	1520	1520	217	85	38	758	240	256
Mercury	mg/kg	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Molybdenum	mg/kg	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Nickel	mg/kg	37	6	13	16	25	23	12	4	2	28	14	19
Selenium	mg/kg	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Silver	mg/kg	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Uranium	mg/kg	0.3	0.1	0.3	0.5	0.3	0.5	0.2	<LOR	<LOR	0.5	0.4	0.7
Vanadium	mg/kg	84	21	26	67	70	73	19	9	8	70	30	45
Zinc	mg/kg	27	8	12	23	11	25	16	7	<LOR	18	32	35
Petroleum Hydrocarbon Fractions													
C6 - C9	mg/kg	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
C10 - C14	mg/kg	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	430	<LOR

Parameter	Unit	Ripstone Creek Tributaries	Ripstone Creek	Isaac River Tributaries				Isaac River			Farm Dams	Palustrine Wetlands	
		RCT4	RC1	U1	U2	U3	U4	I1	I2a	I3	FD2	PW1	PW4
C15 - C28	mg/kg	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	1570	<LOR
C29 - C36	mg/kg	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	890	<LOR
C10 - C36 (sum)	mg/kg	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	2890	<LOR
BTEXN													
Sum of BTEX	mg/kg	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Naphthalene	mg/kg	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR

grey shading denotes values that are above the relevant DGV (Table 2.5)
blue shading denotes values that are above the relevant GV – high (Table 2.5)
<LORresult less than the laboratory limit of reporting

Table 3.3 Sediment quality at sites sampled during aquatic ecology surveys completed in October 2019

Parameter	Units	Ripstone Creek Tributaries	Ripstone Creek	Isaac River Tributaries				Isaac River				Farm Dams			Palustrine Wetlands	
		RCT4	RC1	U1	U2	U3	U4	I1	I1a	I2a	I3	FD2	FD4	FD6	PW1	PW4
Metals and Metalloids																
Aluminium	mg/kg	9780	1350	2610	11000	12400	11100	1600	6560	540	580	11400	11300	9820	9460	8020
Arsenic	mg/kg	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Barium	mg/kg	330	50	50	330	480	280	30	140	<LOR	10	320	380	270	180	170
Beryllium	mg/kg	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	1
Boron	mg/kg	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Cadmium	mg/kg	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Chromium	mg/kg	31	10	9	11	24	23	20	18	5	4	29	21	28	20	21
Cobalt	mg/kg	15	4	4	13	18	18	3	11	<LOR	<LOR	11	19	11	8	11
Copper	mg/kg	20	<LOR	<LOR	41	19	20	<LOR	16	<LOR	<LOR	23	30	23	21	23
Iron	mg/kg	23900	6680	9960	19700	18800	28200	8490	22400	3490	3210	19500	41400	15200	17300	20000
Lead	mg/kg	13	<LOR	6	16	18	20	<LOR	13	<LOR	<LOR	11	20	15	12	15
Manganese	mg/kg	926	219	94	990	1570	1100	100	348	35	35	598	1680	440	228	238
Mercury	mg/kg	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Molybdenum	mg/kg	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Nickel	mg/kg	29	5	7	12	23	19	7	21	3	2	25	24	24	22	20
Selenium	mg/kg	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Silver	mg/kg	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Uranium	mg/kg	0.3	0.1	0.2	0.4	0.4	0.6	0.1	0.5	<LOR	<LOR	0.4	0.8	0.6	0.7	0.8
Vanadium	mg/kg	64	15	17	51	67	65	14	32	6	6	51	56	67	39	44
Zinc	mg/kg	18	<LOR	8	26	16	24	8	33	<LOR	<LOR	21	52	25	41	37
Petroleum Hydrocarbon Fractions																
C6 - C9	mg/kg	<LOR	<LOR	<LOR	–	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
C10 - C14	mg/kg	<LOR	<LOR	<LOR	–	<LOR	<LOR	<LOR	50	<LOR	<LOR	<LOR	<LOR	<LOR	250	<LOR
C15 - C28	mg/kg	<LOR	<LOR	<LOR	–	<LOR	<LOR	<LOR	160	<LOR	<LOR	<LOR	<LOR	<LOR	860	<LOR

Parameter	Units	Ripstone Creek Tributaries	Ripstone Creek	Isaac River Tributaries				Isaac River				Farm Dams			Palustrine Wetlands	
		RCT4	RC1	U1	U2	U3	U4	I1	I1a	I2a	I3	FD2	FD4	FD6	PW1	PW4
C29 - C36	mg/kg	<LOR	<LOR	<LOR	–	<LOR	<LOR	<LOR	200	<LOR	<LOR	<LOR	<LOR	200	530	<LOR
C10 - C36 (sum)	mg/kg	<LOR	<LOR	<LOR	–	<LOR	<LOR	<LOR	410	<LOR	<LOR	<LOR	<LOR	200	1640	<LOR
BTEXN																
Sum of BTEX	mg/kg	<LOR	<LOR	<LOR	–	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Naphthalene	mg/kg	<LOR	<LOR	<LOR	–	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR

grey shading denotes values that are above the relevant DGV (Table 2.5)
blue shading denotes values that are above the relevant GV – high (Table 2.5)
<LOR result less than the laboratory limit of reporting
– parameter not analysed

3.4 Aquatic Plants

A total of 108 aquatic plants species (i.e. species listed as wetland indicator species) are known to occur in the Isaac River sub-basin (DES 2020e; Table 9.2 Appendix D). Of these species, 39 species have been recorded from waterways in and around the Study area during previous surveys (frc environmental 2012, DPM Enviros ciences 2018). All aquatic flora species recorded from the Isaac River sub-basin are considered Least Concern under the NC Act. There are no published records of any aquatic plant species that are listed as vulnerable under the NC Act and the EPBC Act within 30 km of the Project area (DAWE 2020a; DES 2020f).

There is a low diversity and coverage of aquatic plants in the region, typically due to variable water availability, harsh habitat conditions, and cattle grazing and trampling. Aquatic plant communities in the vicinity of the Study area were typically dominated by emergent species such as rushes, sedges and grasses with a greater diversity and abundance typically recorded in the wet season (DPM Enviros ciences 2018). Palustrine wetlands that retained water for the majority of the year supported a higher diversity of aquatic plants compared to waterways.

A total 28 native aquatic plant species from 14 families were recorded at sites in the vicinity of the Project across both surveys. In May 2019, a total of 23 native aquatic plant species from 12 families were recorded (Table 3.4), and in October 2019, a total of 20 native aquatic plant species from 13 families were recorded (Table 3.5). All plants are listed as 'Least Concern' under the EPBC Act and the NC Act.

Most native species recorded are recognised as wetland indicator species (DES 2020b). Two species that are not listed as wetland indicator plants were included in the survey results (lesser joyweed, *Alternanthera denticulata* and spiny-headed mat rush, *Lomandra longifolia*), as they are commonly found around waterbodies and wetlands (Table 3.4; Table 3.5). Emergent species, namely sedges (*Cyperus* spp.), white eclipta (*Eclipta prostrata*) and lesser joyweed (*A. denticulata*), were the most widespread aquatic plants and were growing on the banks or in the shallow margins of the sites where they were recorded. Submerged and floating species were only recorded at farm dam sites.

Overall, aquatic plant diversity and coverage was low at most waterway (creek) and mapped palustrine wetland sites. Coverage at these sites ranged from 0 to 20.6%, with a low diversity of species and growth forms (emergent plants only, and very little in-stream aquatic plant growth). Aquatic plant coverage was higher at farm dam sites, which had more than approximately 15% coverage and up to approximately 93% coverage at some sites, with a higher diversity of species and growth forms recorded (particularly in-stream, and including submerged and floating species).

There was seasonal variation seen at most sites, with lower diversity of species recorded in October 2019 compared to May 2019. The rainfall and flows leading up to the May 2019 survey would have promoted the distribution and growth of aquatic plants along the waterways within the vicinity of the Project. In contrast, aquatic plants would have died off due to the dry conditions prior to the October 2019 survey.

Overall, the aquatic plant species recorded in the field surveys are known to occur in the region (DES 2020b, frc environmental 2012, DPM Enviros ciences 2018).

Table 3.4 Total coverage and taxonomic richness of aquatic plants recorded at each site in May 2019

Family *Species*	Common Name	Growth Form	RIpstone Creek Tributaries	Ripstone Creek	Isaac River Tributaries			Isaac River			Farm Dams	Palustrine Wetlands		*Total*
			RCT4	RC1	U1	U2	U4	I1	I2a	I3	FD2	PW1	PW4	
Amaranthaceae														
Alternanthera denticulata[a]	lesser joyweed	E	1.9	0.8	1.2	0.8	1.6	1.3	–	10.7	–	1.0	0.5	***18.8***
Amaryllidaceae														
Crinum flaccidum	river lily	E	–	–	–	–	–	–	–	–	–	–	0.2	***0.2***
Asteraceae														
Eclipta prostrata	white eclipta	E	–	0.3	2.1	–	3.9	1.6	0.1	0.2	0.1	–	–	***8.3***
Characeae														
Chara sp.	Chara	S	–	–	–	–	–	–	–	–	3.2	–	–	***3.2***
Nitella sp.	Nitella	S	–	–	–	–	–	–	–	–	5.0	–	–	***5.0***
Cyperaceae														
Cyperus difformis	rice sedge	E	0.7	0.3	2.4	–	0.4	1.7	0.7	5.4	–	–	0.2	***11.8***
Cyperus digitatus	flat sedge	E	–	0.1	1.7	–	–	–	–	–	–	–	–	***1.8***
Cyperus distans	slender cyperus	E	–	–	–	–	–	–	0.1	–	–	–	–	***0.1***
Cyperus lucidus	leafy flat sedge	E	–	–	–	–	–	–	0.1	–	–	1.0	–	***1.1***
Cyperus polystachyos	bunchy sedge	E	–	0.3	–	–	–	–	–	0.3	–	–	–	***0.6***
Cyperus sp.	sedge	E	–	–	8.7	0.5	1.1	2.6	–	0.8	–	–	–	***13.7***
Eleocharis sp.	spike rush	E	–	–	–	–	–	–	–	0	–	–	1.5	***1.5***
Fimbristylis quinquangularis	fringe rush	E	–	–	–	1.0	0.6	–	–	0.2	–	15.0	1.5	***18.3***
Haloragaceae														
Myriophyllum verrucosum	red water milfoil	E	–	–	–	–	–	–	–	–	43.5	–	–	***43.5***
Juncaceae														
Juncus usitatus	rush	E	–	–	2.0	–	–	–	–	–	–	–	–	***2.0***

Family *Species*	Common Name	Growth Form	RIpstone Creek Tributaries	Ripstone Creek	Isaac River Tributaries			Isaac River			Farm Dams	Palustrine Wetlands		*Total*
			RCT4	RC1	U1	U2	U4	I1	I2a	I3	FD2	PW1	PW4	
Laxmanniaceae														
Lomandra longifolia[a]	spiny-headed mat rush	E	0.4	–	–	–	–	–	0.1	–	–	–	–	***0.5***
Marsileaceae														
Marsilea drummondii	common nardoo	E	–	0.1	–	–	–	–	–	–	–	–	–	***0.1***
Marsilea mutica	shiny nardoo	E	–	–	–	–	0.2	–	–	–	–	–	0.5	***0.7***
Onagraceae														
Ludwigia octovalis	willow primrose	E	0.2	–	2.5	–	–	–	–	0.4	0.1	–	–	***3.2***
Polygonaceae														
Persicaria lapathifolia	pale knotweed	E	–	–	–	–	–	1.0	–	0.2	–	–	–	***0.2***
Persicaria sp.	knotweed	E	–	–	–	–	–	–	0.1	–	–	–	–	***0.1***
Typhaceae														
Typha domingensis	narrow leaf cumbungi	E	–	–	–	–	–	–	–	–	41	–	–	***41***
Typha sp.	cumbungi	E	–	–	–	–	–	–	–	0.2	–	–	–	***0.2***
Native Species Coverage			**3.2**	**1.9**	**20.6**	**2.3**	**7.8**	**8.2**	**1.2**	**18.4**	**92.9**	**17.0**	**4.4**	
Native Species Richness			**4**	**6**	**7**	**3**	**6**	**5**	**6**	**9**	**6**	**3**	**6**	***23***

[a] not listed as a wetland indicator species but common around waterways and often provides aquatic habitat when present

[b] S = submerged; FF = free floating; F/A = floating/attached; E = emergent

Table 3.5 Total coverage and taxonomic richness of aquatic plants recorded at each site in October 2019

Family *Species Name*	Common Name	Growth Form	Ripstone Creek Tributaries	Ripstone Creek	Isaac River Tributaries				Isaac River				Farm Dams			Palustrine Wetlands		*Total*
			RCT4	RC1	U1	U2	U3	U4	I1	I1a	I2a	I3	FD2	FD4	FD6	PW1	PW4	
Amaranthaceae																		
Alternanthera denticulata[a]	lesser joyweed	E	–	–	0.2	–	–	–	0.3	–	–	1.0	–	–	–	–	–	***1.5***
Asteraceae																		
Eclipta prostrata	white eclipta	E	–	–	0.1	–	–	0.2	0.2	–	–	0.3	–	–	–	–	–	***0.8***
Azollaceae																		
Azolla pinnata	ferny azolla	FF	–	–	–	–	–	–	–	–	–	–	–	–	1.0	–	–	***1.0***
Characeae																		
Chara sp.	Chara	S	–	–	–	–	–	–	–	–	–	–	1.0	–	1.0	–	–	***2.0***
Nitella sp.	Nitella	S	–	–	–	–	–	–	–	–	–	–	2.0	–	–	–	–	***2.0***
Cyperaceae																		
Cyperus digitatus	flat sedge	E	–	–	1.7	–	–	–	–	–	–	0.8	–	1.0	–	–	–	***5.3***
Cyperus distans	slender cyperus	E	–	0.1	–	–	–	–	–	0.4	0.2	–	–	–	–	–	–	***0.7***
Cyperus sp.	sedge	E	–	–	–	–	–	–	–	–	–	0.4	–	–	–	–	–	***0.4***
Haloragaceae																		
Myriophyllum verrucosum	red water milfoil	E	–	–	–	–	–	–	–	–	–	–	25.0	15.0	–	–	–	***40***
Juncaceae																		
Juncus usitatus	rush	E	–	–	0.7	–	–	–	–	–	–	–	–	1.0	–	2.0	–	***3.7***
Laxmanniaceae																		
Lomandra longifolia[a]	spiny-headed mat rush	E	–	0.2	–	–	–	–	–	–	–	–	–	–	–	–	–	***0.2***

Family *Species Name*	Common Name	Growth Form	Ripstone Creek Tributaries	Ripstone Creek	Isaac River Tributaries					Isaac River			Farm Dams			Palustrine Wetlands		*Total*
			RCT4	RC1	U1	U2	U3	U4	I1	I1a	I2a	I3	FD2	FD4	FD6	PW1	PW4	
Marsileaceae																		
Marsilea mutica	shiny nardoo	E	–	–	–	–	–	–	–	–	–	–	–	15.0	–	–	–	***15***
Onagraceae																		
Ludwigia octovalis	willow primrose	E	–	–	0.2	–	–	–	–	–	–	–	–	–	–	–	–	***0.2***
Ludwigia peploides	water primrose	E	–	–	–	–	–	–	–	0.6	–	–	–	–	2.0	–	–	***2.6***
Polygonaceae																		
Persicaria attenuata	smartweed	E	–	–	–	–	–	–	–	–	–	–	–	1.0	–	–	–	***1.0***
Persicaria decipiens	slender knotweed	E	–	–	–	–	–	–	–	–	–	–	1.0	1.0	–	–	–	***2.0***
Persicaria lapathifolia	pale knotweed	E	–	–	–	–	–	–	1.4	2.2	–	0.4	–	–	–	–	–	***4.0***
Potamogetonaceae																		
Potamogeton tricarinatus	floating pondweed	FA	–	–	–	–	–	–	–	–	–	–	–	5.0	10.0	–	–	***15***
Typhaceae																		
Typha domingensis	narrow leaf cumbungi	E	–	–	–	–	–	–	–	–	–	–	15.0	–	–	–	–	***15***
Typha sp.	cumbungi	E	–	–	–	–	–	–	–	–	–	–	–	5.0	1.0	–	–	***6.0***
Native Species Coverage			**0.0**	**0.3**	**2.9**	**0.0**	**0.0**	**0.2**	**1.9**	**3.2**	**0.2**	**2.9**	**44.0**	**44.0**	**15.0**	**2.0**	**0.0**	
Native Species Richness			**0**	**2**	**5**	**0**	**0**	**1**	**3**	**4**	**1**	**5**	**5**	**8**	**5**	**1**	**0**	***21***

[a] not listed as a wetland indicator species but common around waterways and often provides aquatic habitat when present

[c] S = submerged; FF = free floating; FA = floating/attached; E = emergent

3.4.1 Pest Species

A total of 7 introduced aquatic plant species have previously been recorded in the Isaac River sub-basin (DES 2020e):

- white eclipta (*Eclipta prostrata*),
- watercress (*Rorippa nasturtium-aquaticum*),
- yellow nutgrass (*Cyperus esculentus*),
- toad rush (*Juncus bufonius*),
- awnless barnyard grass (*Echinochloa colona*),
- olive hymenachne (*Hymenachne amplexicaulis*), and
- para grass (*Urochloa mutica*).

Of these, one species, olive hymenachne (*Hymenachne amplexicaulis*), is a Weed of National Significance and a restricted invasive plant under the *Biosecurity Act 2014.*

One introduced species of aquatic plant was recorded during the surveys: white eclipta (*E. prostrata*). This species is not listed as a Weed of National Significance or as an invasive plant under the *Biosecurity Act 2014,* and is considered naturalised across most of Qld (Stephens & Dowling 2002).

3.5 Aquatic Macroinvertebrates

In previous studies in the vicinity of the Project by frc environmental (2012) and DPM Enviros ciences (2018), macroinvertebrate communities were in similar condition to those in the broader region. Taxonomic richness, PET Richness, percentage of pollutant tolerant taxa and SIGNAL 2 scores were below or within biological guideline ranges derived for the Isaac River sub-basin, indicating that sites are in moderate condition overall to support healthy macroinvertebrate communities (DPM Enviros ciences 2018, frc environmental 2012).

Macroinvertebrate communities in the previous baseline surveys were dominated by non-biting midges (sub-families Tanypodinae and Chironominae), biting midges (family Ceratopogonidae) and mayflies (family Caenidae) in both seasons (frc environmental 2012). These macroinvertebrate taxa are typically tolerant to a range of environmental conditions and are often recorded in moderately disturbed aquatic ecosystems. Sensitive taxa were also recorded, and were more prevalent during the post-wet season survey when the Isaac River was flowing (and therefore a wider variety of instream habitat types was present).

No exotic or threatened macroinvertebrate or macrocrustacean species were recorded in previous surveys completed on the waterways and wetlands in the vicinity of the Project (frc environmental 2012, DPM Enviros ciences 2018), and no records of listed macroinvertebrates or macrocrustaceans are known from the Fitzroy River basin and Isaac River sub-basin (DES 2020b, URS 2013).

3.5.1 Community Composition

A total of 23,857 individuals from 83 taxa were collected in samples collected across all sites and both surveys. In both bed and edge habitats, macroinvertebrate communities were typically dominated by several major groups that were common across the majority of sites in moderate to high abundance, including:

- flies (order Diptera) with high abundances of non-biting midges (subfamilies Chironominae and Tanypodinae) and biting midges (family Ceratopogonidae) common in samples,
- beetles (order Coleoptera) with high abundances of diving beetles (family Dytiscidae) and moss beetles (family Hydraenidae), and
- freshwater snails (class Gastropoda, primarily families Lymnaeidae, Planorbidae and Thiaridae).

All of these taxa are common in the region and are considered to be tolerant to a range of environmental conditions (where sensitivity ratings are available).

Overall, the community composition of the samples is representative of macroinvertebrate communities of the wider region with similar taxa dominating the composition (DPM Enviroscences 2018, frc environmental 2012).

3.5.2 Replicate Samples

3.5.2.1 Average Abundance

Bed Habitat

The average abundance of macroinvertebrates in bed habitat varied substantially between sites, and between surveys. It was particularly high at site FD6 (farm dam approximately 2.5 km south of the Project area) in October 2019 (Figure 3.8). This was primarily due to high numbers of tolerant taxa (e.g. non-biting midges, sub-families Tanypodinae and Chironominae).

At site FD2 (farm dam within the Project area), which was sampled during both surveys, abundance was substantially higher in May than in October 2019 (Figure 3.8).

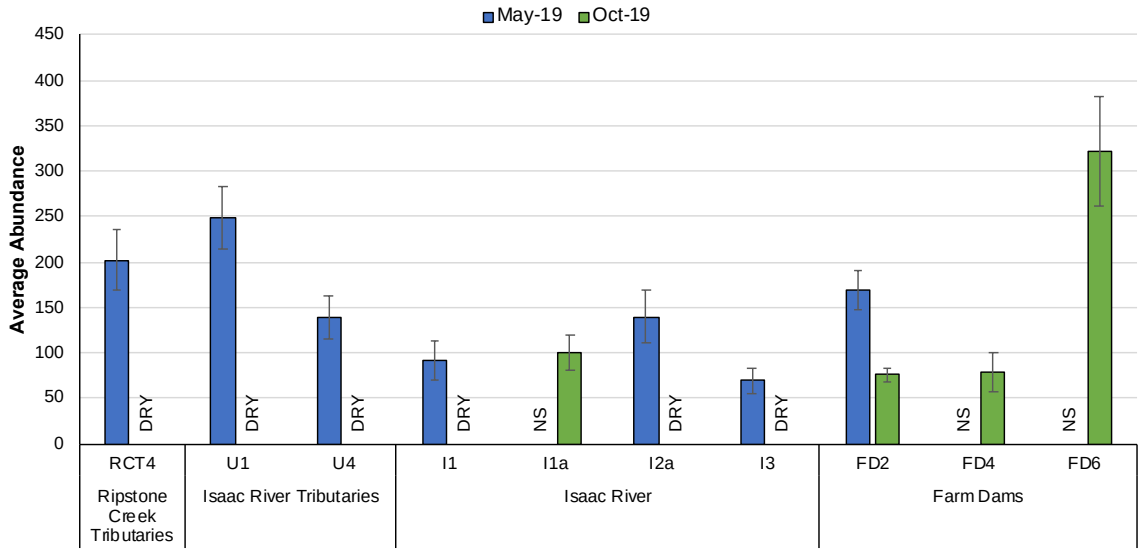


Figure 3.8 Average abundance of macroinvertebrates in bed habitat at each site; NS indicates site not surveyed, DRY indicates the site was dry and could not be surveyed

Edge Habitat

Similar to bed habitat, the average abundance of macroinvertebrates in edge habitat varied substantially between sites, and between surveys. Average abundance in October (i.e. the early-wet season) was within the range of that recorded in May (i.e. the late-wet season).

At site FD2, which was sampled during both surveys, abundance was substantially higher in October than in May 2019 (Figure 3.9).

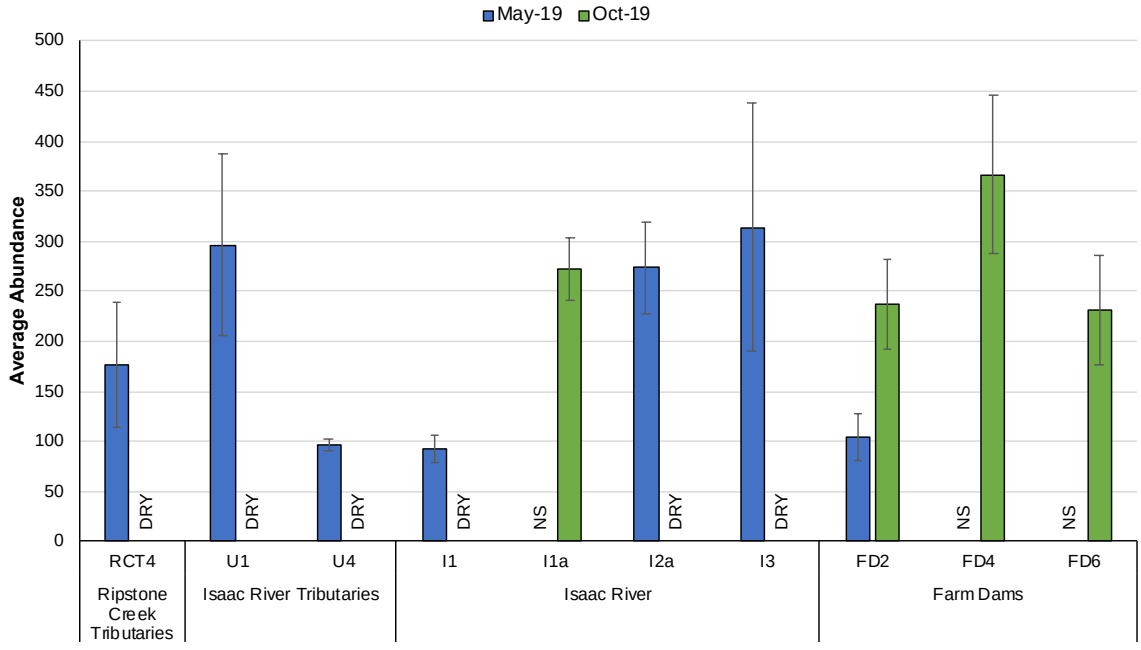


Figure 3.9 Average abundance of macroinvertebrates in edge habitat at each site; NS indicates site not surveyed, DRY indicates the site was dry and could not be surveyed

3.5.2.2 Average Taxonomic Richness

Bed Habitat

The average taxonomic richness of macroinvertebrates in bed habitat varied between sites. It was particularly high at most of the farm dams (i.e. site FD2 in May and October and site FD6 in October) (Figure 3.10). It was lowest at site I1a (5 taxa), on the Isaac River downstream of the Project.

At site FD2, which was sampled during both surveys, average taxonomic richness was similar between surveys (Figure 3.10).

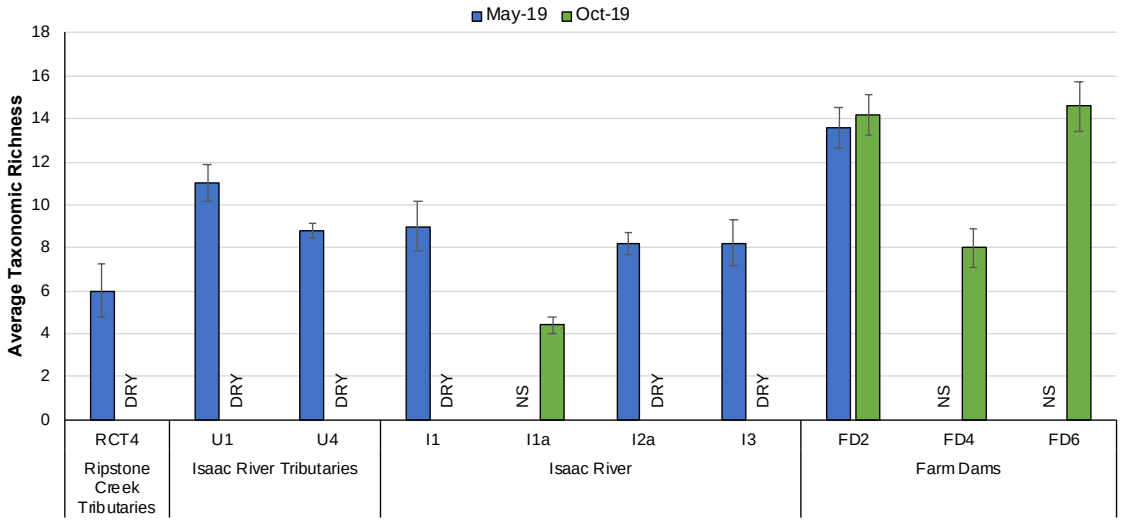


Figure 3.10 Average taxonomic richness of macroinvertebrates in bed habitat at each site; NS indicates site not surveyed, DRY indicates the site was dry and could not be surveyed

Edge Habitat

The average taxonomic richness of macroinvertebrates in edge habitat varied between sites. It was particularly high at most of the farm dams (i.e. site FD2 and site FD6) in October 2019 (Figure 3.11). There was less variation in average taxonomic richness of macroinvertebrates between sites in edge habitat compared with bed habitat, and in October (i.e. the early-wet season) it was within the range of that in May (i.e. the late-wet season).

At site FD2, which was sampled during both surveys, average taxonomic richness was higher in October than in May 2019 (Figure 3.11).

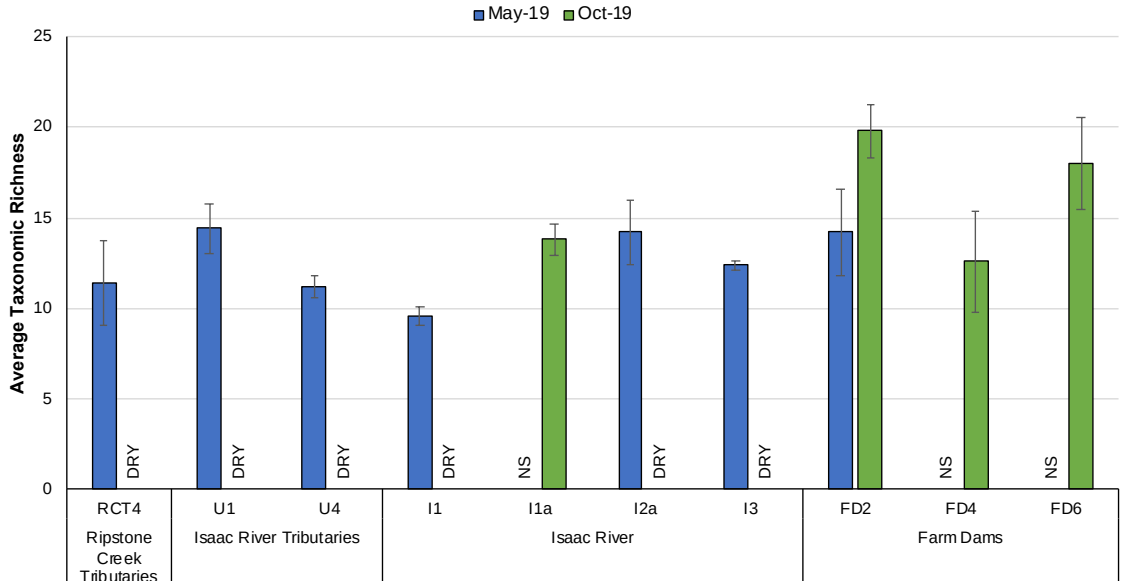


Figure 3.11 Average taxonomic richness of macroinvertebrates in edge habitat at each site; NS indicates site not surveyed, DRY indicates the site was dry and could not be surveyed

3.5.2.3 Average PET Richness

Bed Habitat

The average PET richness of macroinvertebrates in bed habitat varied between sites. Most sites contained at least one PET taxa on average, indicating that conditions were suitable to support more sensitive macroinvertebrate communities. The exception was site I1a (Isaac River downstream of the Project), where no PET taxa were recorded (Figure 3.12). This site consisted of a small isolated pool with limited instream habitat structure and diversity. The most frequently recorded PET taxa were mayflies (Ephemeroptera), which are considered to be common in the region and relatively tolerant compared with other PET taxa.

Average PET richness was highest at most of the farm dams (i.e. site FD2 and site FD6) in October 2019 (Figure 3.12). These sites provided more diverse habitat (including submerged and emergent aquatic plants) compared with the isolated pools that comprised riverine sites (which had low water level and therefore less habitat structural complexity). At site FD2, which was sampled during both surveys, average PET richness was slightly higher in October than in May (Figure 3.12).

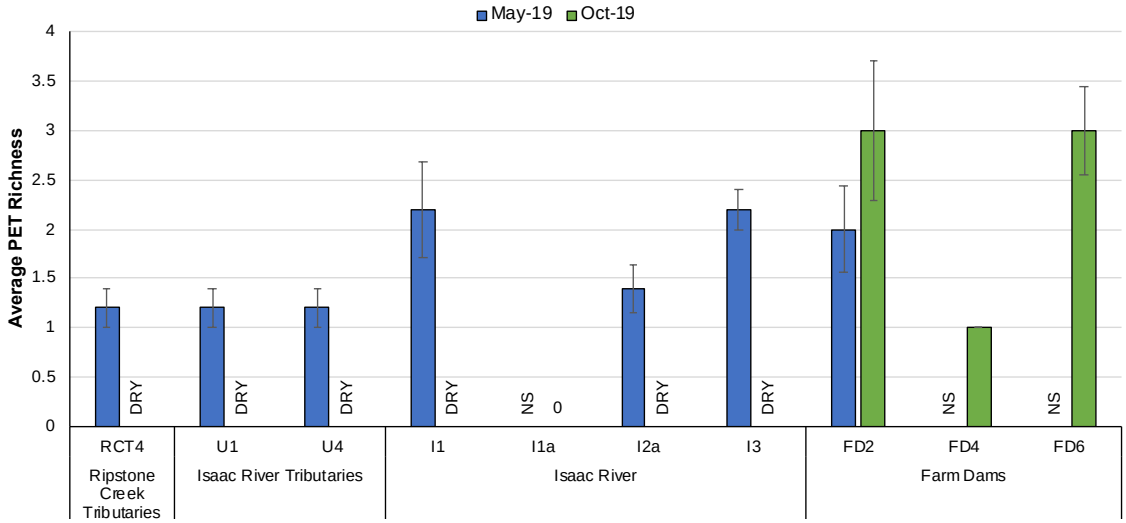


Figure 3.12 Average PET richness of macroinvertebrates in bed habitat at each site; NS indicates site not surveyed, DRY indicates the site was dry and could not be surveyed

Edge Habitat

The average PET richness of macroinvertebrates in edge habitat varied between sites and between surveys. All sites contained at least 0.6 PET taxa on average, indicating that conditions were suitable to support more sensitive macroinvertebrate communities. The most frequently recorded PET taxa were mayflies (Ephemeroptera), which are considered to be common in the region and relatively tolerant compared with other PET taxa.

Average PET richness was highest at most of the farm dams (i.e. site FD2 and site FD6) in October 2019; and at site I3 (Isaac River downstream of the Project) in May 2019 (Figure 3.13). These sites consisted of large pools, providing more stable habitat for aquatic macroinvertebrate communities than most other sites (which consisted of small shallow pools with limited habitat availability and complexity). At site FD2 (farm dam), which was sampled during both surveys, average PET richness was higher in October than in May 2019 (Figure 3.13).

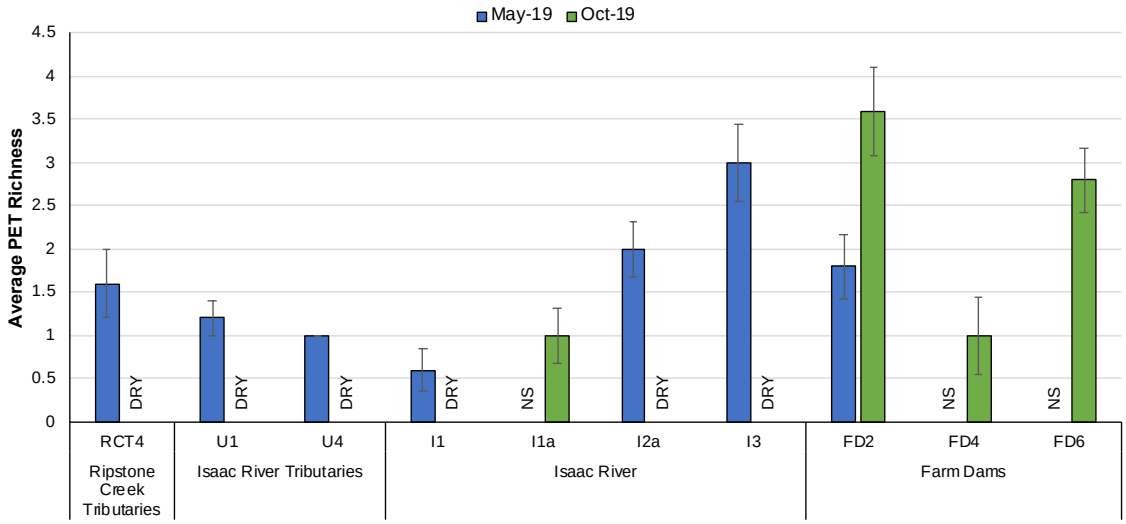


Figure 3.13 Average PET richness of macroinvertebrates in edge habitat at each site; NS indicates site not surveyed, DRY indicates the site was dry and could not be surveyed

3.5.2.4 Average SIGNAL 2 Score

Bed and Edge Habitat

The average SIGNAL 2 scores of macroinvertebrates in bed and edge habitat did not vary substantially between sites or between surveys. They were lowest at site FD4 (farm dam) in October 2019 (Figure 3.14 and Figure 3.15). At site FD2 (farm dam), which was sampled during both surveys, SIGNAL 2 scores were similar in May and October 2019.

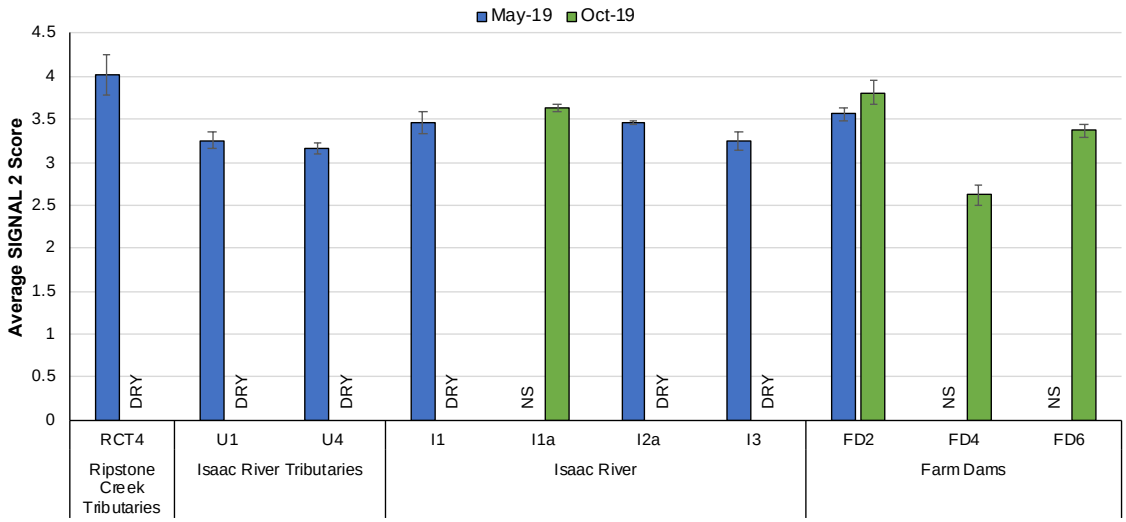


Figure 3.14 Average SIGNAL 2 scores of macroinvertebrates in bed habitat at each site; NS indicates site not surveyed, DRY indicates the site was dry and could not be surveyed

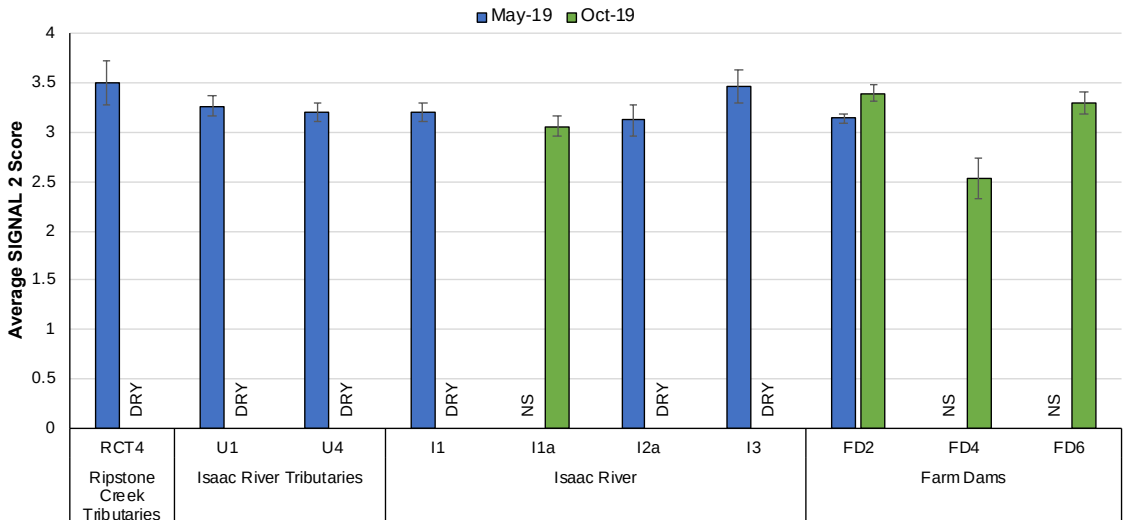


Figure 3.15 Average SIGNAL 2 scores of macroinvertebrates in edge habitat at each site; NS indicates site not surveyed, DRY indicates the site was dry and could not be surveyed

3.5.3 AUSRIVAS Samples

3.5.3.1 Total Taxonomic Richness

Bed Habitat

Overall, total taxonomic richness of macroinvertebrates in bed habitat was low to moderate, and did not vary substantially between seasons (Figure 3.16). In May 2019, total taxonomic richness was equal to or within the WQO range at most sites except for RCT4 (isolated pool on a tributary of Ripstone Creek south of the Project area) and I2a (isolated pool on the Isaac River downstream of the Project). In October 2019, total taxonomic richness was equal to or within the WQO range at half of the sites, and was below the WQO range at site FD4 (farm dam) and site I1a (isolated pool on the Isaac River). At site FD2 (farm dam), which was sampled during both surveys, total taxonomic richness did not vary between May and October 2019.

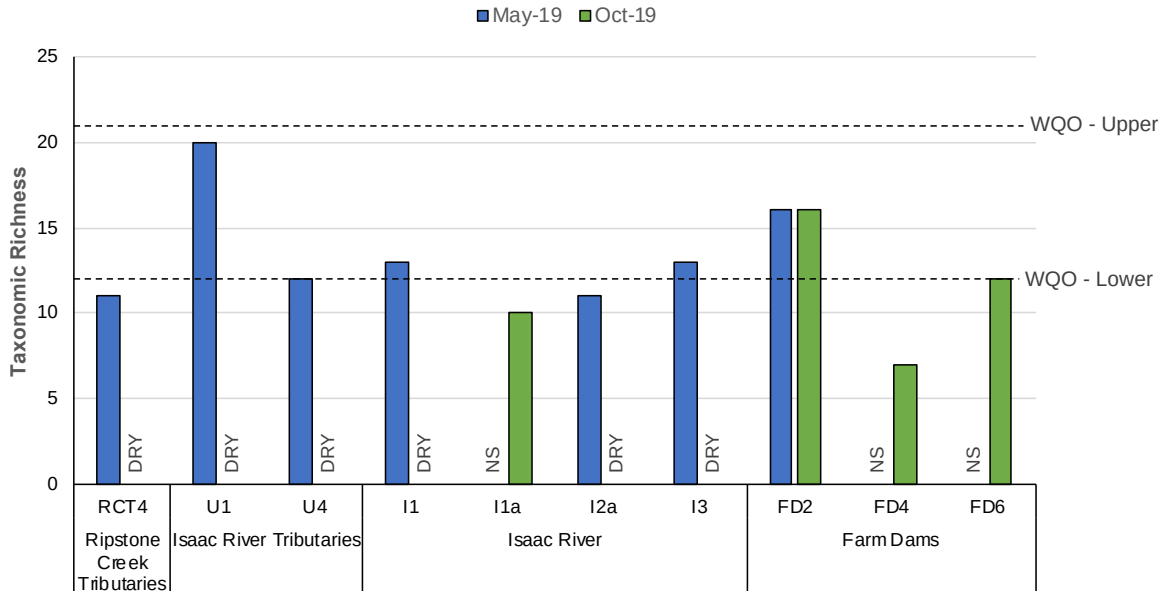


Figure 3.16 Total taxonomic richness of macroinvertebrates in bed habitat at each site; NS indicates site not surveyed, DRY indicates the site was dry and could not be surveyed

Edge Habitat

Overall, total taxonomic richness of macroinvertebrates in edge habitat was low at most sites, and did not vary substantially between seasons (Figure 3.17). Total taxonomic richness was below the WQO range at all sites during both surveys, except at site U1 (unnamed tributary of the Isaac River downstream of the Project area), where it was within the WQO range in May 2019 (Figure 3.17). At site FD2 (farm dam), which was sampled during both surveys, total taxonomic richness was similar between October (19 taxa) and May (22 taxa).

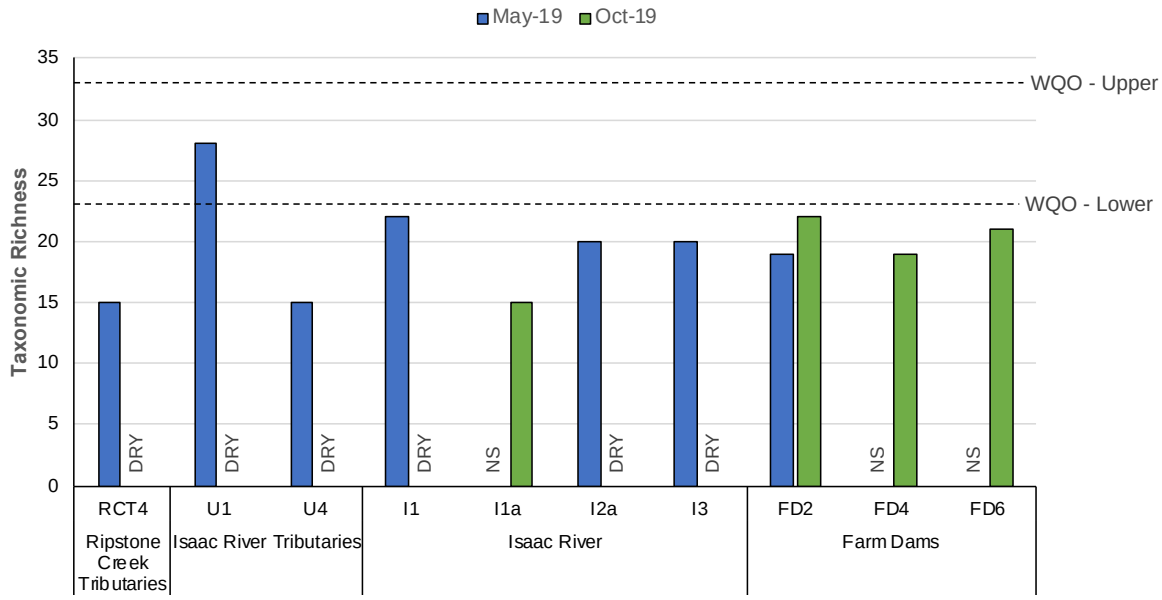


Figure 3.17 Total taxonomic richness of macroinvertebrates in edge habitat at each site; NS indicates site not surveyed, DRY indicates the site was dry and could not be surveyed

3.5.3.2 Total PET Richness

Bed Habitat

Overall, total PET richness of macroinvertebrates in bed habitat was low to moderate, and did not vary substantially between seasons (Figure 3.18). Most sites contained at least one sensitive PET taxa, except for site FD4 (farm dam); this site provided relatively homogeneous habitat for aquatic macroinvertebrates.

In May 2019, total PET richness was equal to or within the WQO range at most sites except at sites within the Study area that consisted of small, shallow isolated pools (i.e. sites U1, U4 and RCT4), where it was below the WQO range. In October 2019, total PET richness was equal to or within the WQO range at most sites, except site I1a (Isaac River downstream of the Project area) where it was below the WQO range (Figure 3.18). At site FD2 (farm dam), which was sampled during both surveys, total PET richness did not vary between May and October 2019.

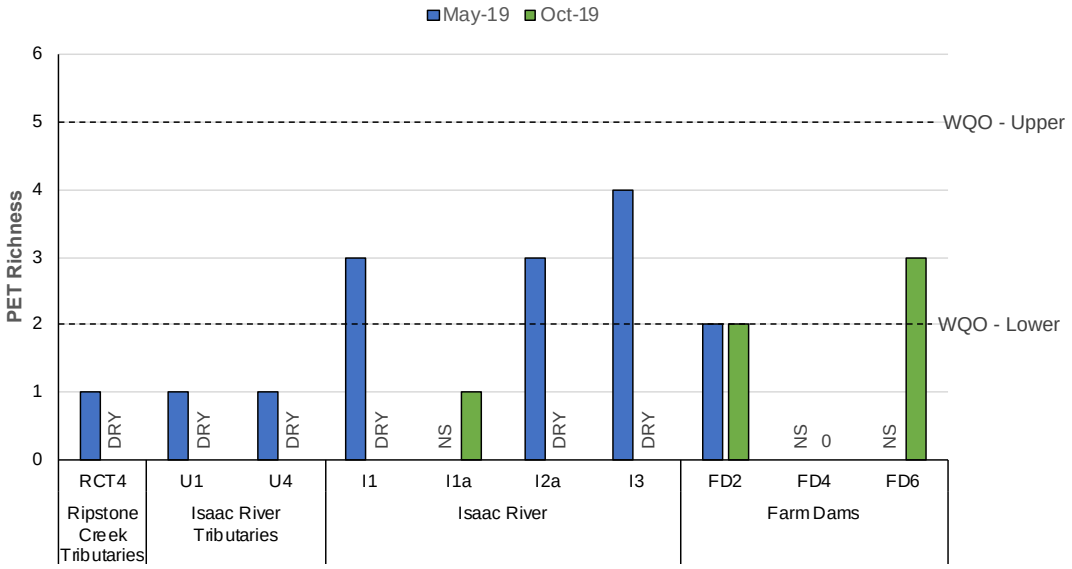


Figure 3.18 Total PET richness of macroinvertebrates in bed habitat at each site; NS indicates site not surveyed, DRY indicates the site was too dry to survey

Edge Habitat

Overall, total PET richness of macroinvertebrates in edge habitat was low to moderate, and did not vary substantially between seasons (Figure 3.19). Most sites contained at least one sensitive PET taxa, except for site I1a (Isaac River downstream of the Project area).

In May 2019, total PET richness was within the WQO range at most sites except at sites U4 (unnamed tributary of the Isaac River within the Project area) and RCT4 (unnamed tributary of Ripstone Creek south of the Project area), where it was below the WQO range (Figure 3.19). In October 2019, total PET richness was equal to or within the WQO range at most sites, except site FD4 (farm dam) where it was below the WQO range. At site FD2 (farm dam), which was sampled during both surveys, total PET richness did not vary between May and October 2019.

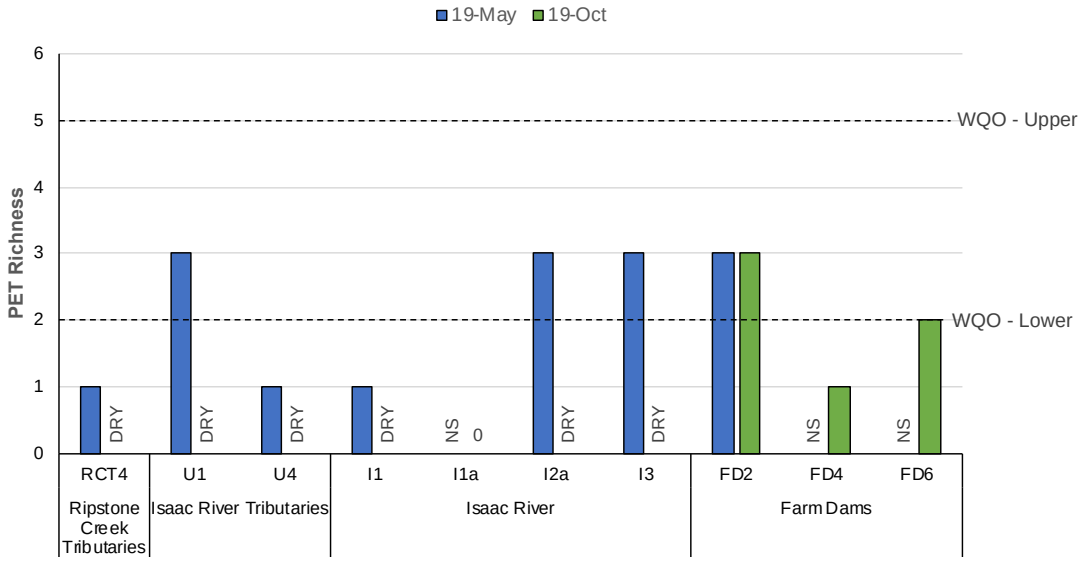


Figure 3.19 Total PET richness of macroinvertebrates in edge habitat at each site; NS indicates site not surveyed, DRY indicates the site was too dry to survey

3.5.3.3 Total SIGNAL 2 Score

Bed Habitat

Overall, total SIGNAL 2 scores of macroinvertebrates in bed habitat varied from low to high (Figure 3.20). In May 2019, total SIGNAL 2 scores were within or above the WQO range at most sites except at sites on unnamed tributaries of the Isaac River (i.e. sites U1 and U4), where they were slightly below the WQO range. In October 2019, SIGNAL 2 scores were within the WQO range at most sites, except site I1a (Isaac River downstream of the Project) where it was slightly below the WQO range. At site FD2 (farm dam), which was sampled during both surveys, total SIGNAL 2 scores did not vary substantially between May and October 2019.

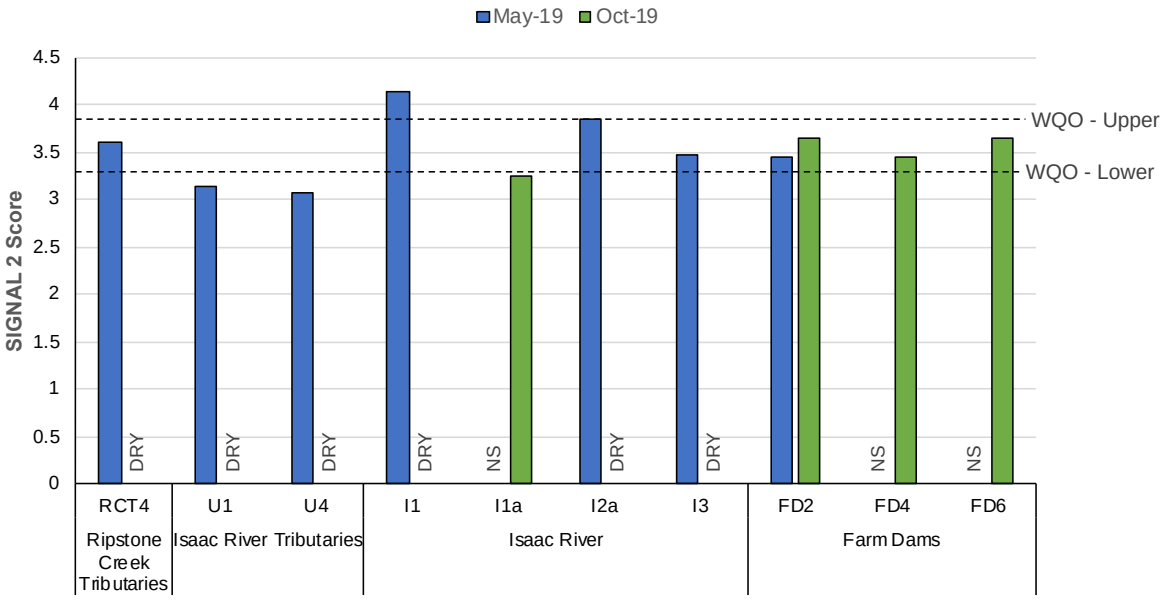


Figure 3.20 Total SIGNAL 2 scores of macroinvertebrates in bed habitat at each site; NS indicates site not surveyed, DRY indicates the site was too dry to survey

Edge Habitat

Overall, total SIGNAL 2 scores of macroinvertebrates in edge habitat varied from low to moderate (Figure 3.21). In May 2019, total SIGNAL 2 scores were within the WQO range at most sites except at sites FD2 (farm dam) and U4 (unnamed tributary of the Isaac River within the Project area), where they were slightly below the WQO range. In October 2019, SIGNAL 2 scores were below the WQO range at all sites. At site FD2 (farm dam), which was sampled during both surveys, total SIGNAL 2 scores did not vary substantially between May and October 2019.

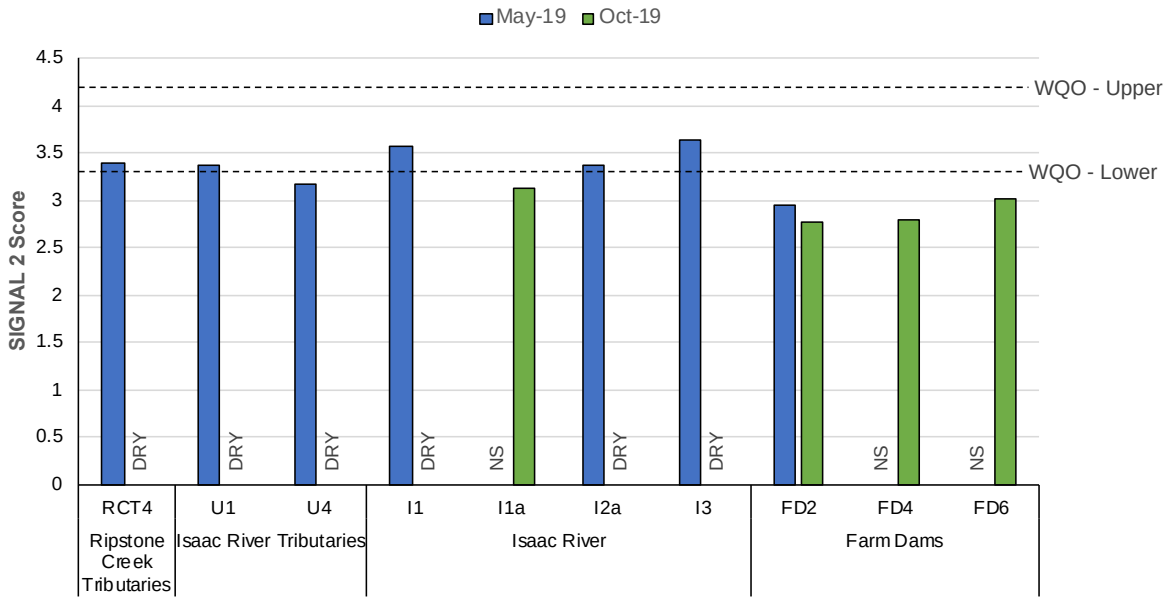


Figure 3.21 Total SIGNAL 2 scores of macroinvertebrates in edge habitat at each site; NS indicates site not surveyed, DRY indicates the site was too dry to survey

3.5.3.4 SIGNAL 2 / Family Bi-plots

Bed Habitat

On SIGNAL 2 / family bi-plots for macroinvertebrate communities in bed habitat (Chessman 2003), most sites were distributed between quadrants one and three (refer to Figure 2.3; Figure 3.22), indicating favourable habitat (i.e. chemically favourable waters) or toxic pollution / harsh physical conditions respectively. Sites in quadrant three were likely influenced primarily by a combination of harsh physical conditions (given the ephemeral nature of the waterways assessed), and also poor water quality (with several physicochemical, nutrient and metals parameters exceeding relevant WQOs at the relevant sites; Table 3.1).

The exceptions were:

- Site U1 (unnamed tributary of the Isaac River downstream of the Project area), which was in quadrant two in May 2019 indicating high salinity or nutrient concentrations (which may be natural). Water quality results indicated high concentrations of nutrients (total and organic nitrogen, total phosphorus and ammonia) at this site, though the concentrations of these parameters were also high at other sites during the survey (Table 3.1).
- Site U4 (unnamed tributary of the Isaac River within the Project area), which was on the border of quadrant two and quadrant four in May 2019, indicating industrial or agricultural pollution and / or high salinity or nutrient concentrations (which may be natural). Water quality results indicated high concentrations of nutrients (total and organic nitrogen, filterable reactive phosphorus, total phosphorus and ammonia) at this site, though the concentrations of these parameters were also high at other sites during the survey (Table 3.1). This site was highly disturbed by cattle access during the survey and consisted of dry shallow pools.

- Site I1a (Isaac River downstream of the Project area), which was on the border of quadrant three and quadrant four in October 2019, indicating toxic pollution or harsh physical conditions, and industrial or agricultural pollution. Given the aquatic habitat condition and water quality results at this site, it is likely that a combination of harsh physical conditions and agricultural pollution contributed to this result. This site consisted of an isolated, drying pool during the field survey, and was impacted by cattle access and trampling (with high concentrations of nutrients and total petroleum hydrocarbons present in the water; Table 3.1).

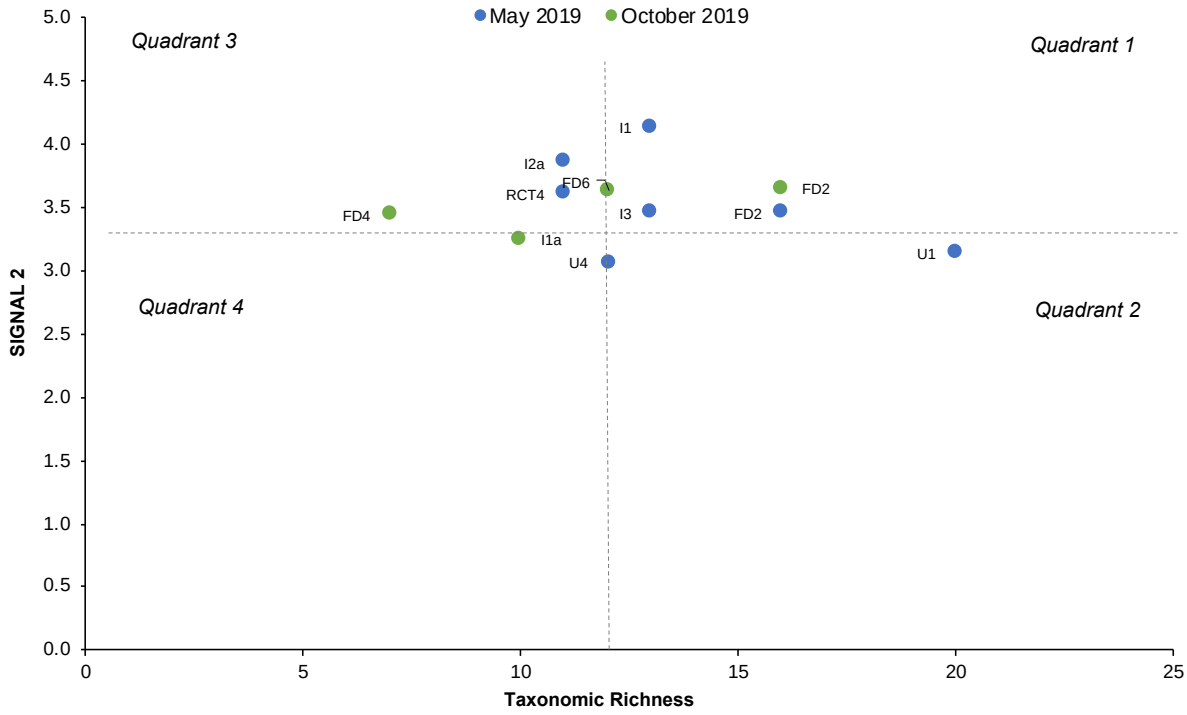


Figure 3.22 SIGNAL 2 / family bi-plot of macroinvertebrates in bed habitat at each site

Edge Habitat

On SIGNAL 2 / family bi-plots for macroinvertebrate communities in edge habitat, most sites in May 2019 were in quadrant 3 (refer to Figure 2.3; Figure 3.23), indicating toxic pollution or harsh physical conditions. Sites in quadrant three were likely influenced primarily by a combination of harsh physical conditions (given the ephemeral nature of the waterways assessed), and also poor water quality (with several physicochemical, nutrient and metals parameters exceeding relevant WQOs at the relevant sites; Table 3.1). The exceptions were:

- Site U1 (unnamed tributary of the Isaac River downstream of the Project area), which was in quadrant one in May 2019 indicating favourable habitat (i.e. chemically dilute waters) but close to the border of quadrant two (suggesting high salinity or nutrient concentrations, which may be natural). Water quality results indicated high concentrations of nutrients (total and organic nitrogen, total phosphorus and ammonia) at this site, though the concentrations of these parameters were also high at other sites during the survey (Table 3.1).

- Site FD2 (farm dam), which was in quadrant four, indicating industrial or agricultural pollution (likely agricultural given the surrounding land-uses at this site).

In October 2019, all sites were within quadrant four, indicating industrial or agricultural pollution (likely agricultural given the surrounding land-uses). However, the dry conditions and low water levels during this survey are likely to have influenced this result.

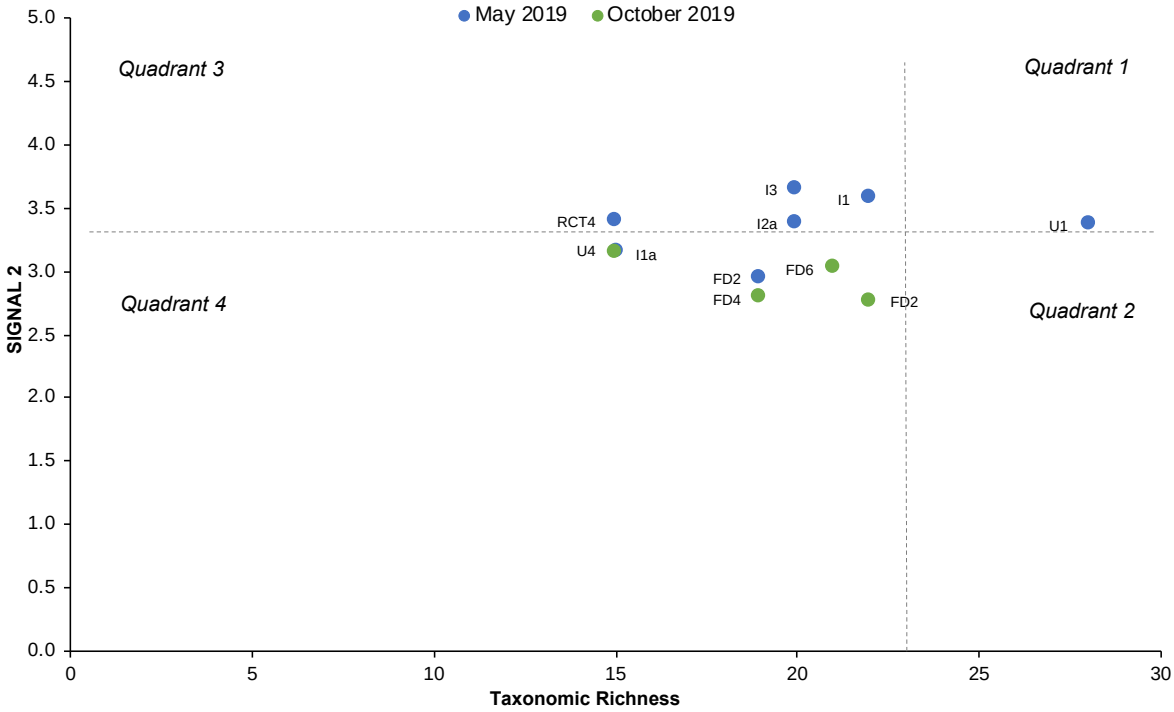


Figure 3.23 SIGNAL 2 / family bi-plot of macroinvertebrates in edge habitat at each site

3.5.3.5 Macrocrustaceans

Five groups of macrocrustaceans are known from the region and have been recorded during previous surveys in the vicinity of the Project (DPM Enviros ciences 2018, frc environmental 2012):

- fairy shrimp (order Anostraca),
- freshwater shrimp (family Atyidae),
- freshwater prawns (family Palaemonidae),
- yabbies (family Parastacidae), and
- freshwater crab (family Gecarcinucidae).

In the 2019 surveys, four species of macrocrustaceans were recorded during fish sampling (Table 3.6). All species have been recorded in previous surveys completed in waterways in the Isaac River catchment (DPM Enviros ciences 2018). Freshwater prawns (*Macrobrachium* sp.) and freshwater shrimp (family Atyidae) were particularly abundant and were recorded at most sites. In contrast, only one redclaw yabby (*Cherax quadricarinatus*) and one fairy shrimp (order Anostraca) were recorded at one site on the Isaac River and one site on a tributary of the Isaac River, respectively, in May 2019.

3.6 Aquatic Vertebrates

3.6.1 Fish

A total of 3120 native fish, comprising 13 species from 10 families, were recorded from the waterways and wetlands across both surveys (Table 3.7 and Table 3.8). Fish communities were dominated by small bodied species, with the lack of large-bodied fish likely due to the paucity of deep pool habitat. Most sites contained fish communities, except for site U4 (unnamed tributary of the Isaac River within the Project area) where no fish were recorded (Figure 3.24). This site consisted of small, isolated pools that provided poor habitat for fish communities.

The diversity of fish was consistent between surveys, but abundance varied, and was higher in the October 2019 than in May 2019. This was likely a result of lower water levels in October 2019 concentrating fish communities together in remaining pools (Table 3.7). Abundance and richness were lower at sites located on tributaries (i.e. at minor waterways within the Project area) compared to major waterways (i.e. the Isaac River) and dams where there was a greater availability of water and habitat.

Carp gudgeons (*Hypseloetris* spp.) were the most abundant native species recorded in the October 2019 survey, although Agassiz's glassfish (*Ambassis agassizii*) were the most abundant native species in the May 2019 survey. Fly-specked hardyheads (*Craterocephalus stercusmuscarum*), and eastern rainbowfish (M*elanotaenia splendida splendida*) were also relatively abundant in both surveys. These species were also widespread in both surveys, occurring at all or most sites.

The least abundant and widespread fish species recorded were the Australian smelt (*Retropinna semoni*), which was only recorded at one site (I3 on the Isaac River downstream of the Project area) in May 2019 and the Rendahl's catfish (*Porochilus rendahli*), which was only recorded at one site (FD4 on a farm dam within the Project area) in October 2019 (Table 3.7).

In both surveys, predominantly adult fish were caught, particularly at sites on the tributaries (i.e. the minor waterways within the Project area) where low numbers of fish were caught; while the farm dams and riverine sites supported populations of intermediate and juvenile fish (Figure 3.24).

Table 3.6 Macrocrustaceans recorded during both surveys

Taxonomic Group *Species*	Common Name	May-19								Oct-19					
		Ripstone Creek Tributaries	Isaac River Tributaries		Isaac River			Farm Dams	*Total May*	Isaac River	Farm Dams			*Total Oct*
		RCT4	U1	U4	I1	I2a	I3	FD2		I1a	FD2	FD4	FD6	
Anostraca	fairy shrimp	–	1 [a]	–	– [a]	–	–	–	***1***	–	–	–	–	***0***
Atyidae	freshwater shrimp	–	– [a]	–	10 [a]	158	56	623	***847***	115	24	158	131	***428***
Gecarcinucidae														
Holthuisana transversa	freshwater crab	–	3	3	–	6	–	–	***12***	–	–	–	–	***0***
Palaemonidae														
Macrobrachium sp.	freshwater prawn	–	–	–	–	50	47	9	***106***	301	29	136	167	***633***
Parastacidae														
Cherax depressus	orange-fingered yabby	–	2	–	–	2	15	–	***19***	–	–	–	1	***1***
Cherax quadricarinatus	redclaw yabby	–	–	–	–	–	1	–	***1***	–	–	–	–	***0***
Cherax sp.	yabby	–	– [a]	–	–	–	–	–	***0***	–	–	1	2	***3***
Total Abundance		**0**	**6**	**3**	**10**	**216**	**119**	**632**	**986**	**416**	**53**	**295**	**301**	***1065***

[a] indicates species recorded during seasonal surveys at this site by frc environmental (2012)

Table 3.7 Fish species abundance and richness during aquatic ecology surveys completed in May 2019

Family *Species Name*	Common Name	Ripstone Creek Tributaries RCT4	Isaac River Tributaries U1	 U4	Isaac River I1	 I2a	 I3	Farm Dams FD2	*Total*
Ambassidae									
Ambassis agassizii	Agassiz's glassfish	–	63	–	4	7	60	5	***139***
Atherinidae									
Craterocephalus stercusmuscarum	fly-specked hardyhead	–	–	–	–	–	–	108	***108***
Cichlidae									
Oreochromis mossambicus[a]	mozambique tilapia	–	–	–	5	5	48	–	***58***
Clupeidae									
Nematalosa erebi	bony bream	–	–	–	–	–	3	1	***4***
Eleotridae									
Hypseleotris spp.[b]	carp gudgeon	–	2	–	14	22	6	47	***91***
Mogurnda adspersa	purple-spotted gudgeon	–	–	–	–	1	1	–	***2***
Oxyeleotris lineolatus	sleepy cod	–	–	–	–	–	6	1	***7***
Melanotaeniidae									
Melanotaenia splendida splendida	eastern rainbowfish	–	–	–	27	4	2	8	***41***
Percichthyidae									
Macquaria ambigua	golden perch	–	–	–	2	16	1	–	***19***
Plotosidae									
Neosilurus hyrtlii	Hyrtl's catfish	–	–	–	1	1	2	–	***4***
Porochilus rendahli	Rendahl's catfish	–	–	–	–	–	–	–	***0***
Tandanus tandanus	freshwater catfish	–	–	–	–	–	–	–	***0***
Retropinnidae									
Retropinna semoni	Australian smelt	–	–	–	–	–	1	–	***1***

Family	Common Name	Ripstone Creek Tributaries	Isaac River Tributaries		Isaac River			Farm Dams	*Total*
Species Name		RCT4	U1	U4	I1	I2a	I3	FD2	
Terapontidae									
Leiopotherapon unicolor	spangled perch	2	–	–	65	50	2	–	***119***
Native Species Abundance		**2**	**65**	**0**	**113**	**101**	**84**	**170**	***535***
Exotic Species Abundance		**0**	**0**	**0**	**5**	**5**	**48**	**0**	***58***
Native Species Richness		**1**	**2**	**0**	**6**	**7**	**10**	**6**	***11***
Exotic Species Richness		**0**	**0**	**0**	**1**	**1**	**1**	**0**	***1***

[a] restricted noxious pest species under the *Biosecurity Act 2014*

[b] count incorporates multiple species, including western carp gudgeons (*Hypseleotris klunzingeri*), firetail gudgeons (*Hypseleotris galii*) and common carp gudgeons (*Hypseleotris* sp.); these species are difficult to reliably identify to species level in the field and can hybridise

– not recorded

Table 3.8 Fish species abundance and richness during aquatic ecology surveys completed in October 2019

Family *Species Name*	Common Name	Isaac River	Farm Dams			Total
		I1a	FD2	FD4	FD6	
Ambassidae						
Ambassis agassizii	Agassiz's glassfish	6	46	14	271	***337***
Atherinidae						
Craterocephalus stercusmuscarum	fly-specked hardyhead	–	221	36	24	***281***
Cichlidae						
Oreochromis mossambicus[a]	mozambique tilapia	–	3	3	–	***6***
Clupeidae						
Nematalosa erebi	bony bream	5	62	14	20	***101***
Eleotridae						
Hypseleotris spp.[b]	carp gudgeon	155	90	22	1021	***1288***
Mogurnda adspersa	purple-spotted gudgeon	–	–	–	16	***16***
Oxyeleotris lineolatus	sleepy cod	–	2	–	–	***2***
Melanotaeniidae						
Melanotaenia splendida splendida	eastern rainbowfish	142	49	43	320	***554***
Percichthyidae						
Macquaria ambigua	golden perch	–	–	–	–	***0***
Plotosidae						
Neosilurus hyrtlii	Hyrtl's tandan	–	1	–	–	***1***
Porochilus rendahli	Rendahl's catfish	–	–	2	–	***2***
Tandanus tandanus	freshwater catfish	2	–	–	–	***2***
Retropinnidae						
Retropinna semoni	Australian smelt	–	–	–	–	***0***
Terapontidae						
Leiopotherapon unicolor	spangled perch	–	1	–	–	***1***
Native Species Abundance		**310**	**472**	**131**	**1672**	***2585***
Exotic Species Abundance		**0**	**3**	**3**	**0**	***6***

Family *Species Name*	Common Name	Isaac River	Farm Dams			Total
		I1a	FD2	FD4	FD6	
	Native Species Richness	**5**	**8**	**6**	**6**	***11***
	Exotic Species Richness	**0**	**1**	**1**	**0**	***1***

[a] restricted noxious pest species under the *Biosecurity Act 2014*

[b] count incorporates multiple species, including western carp gudgeons (*Hypseleotris klunzingeri*), firetail gudgeons (*Hypseleotris galii*) and common carp gudgeons (*Hypseleotris* sp.); these species are difficult to reliably identify to species level in the field and can hybridise

– not recorded

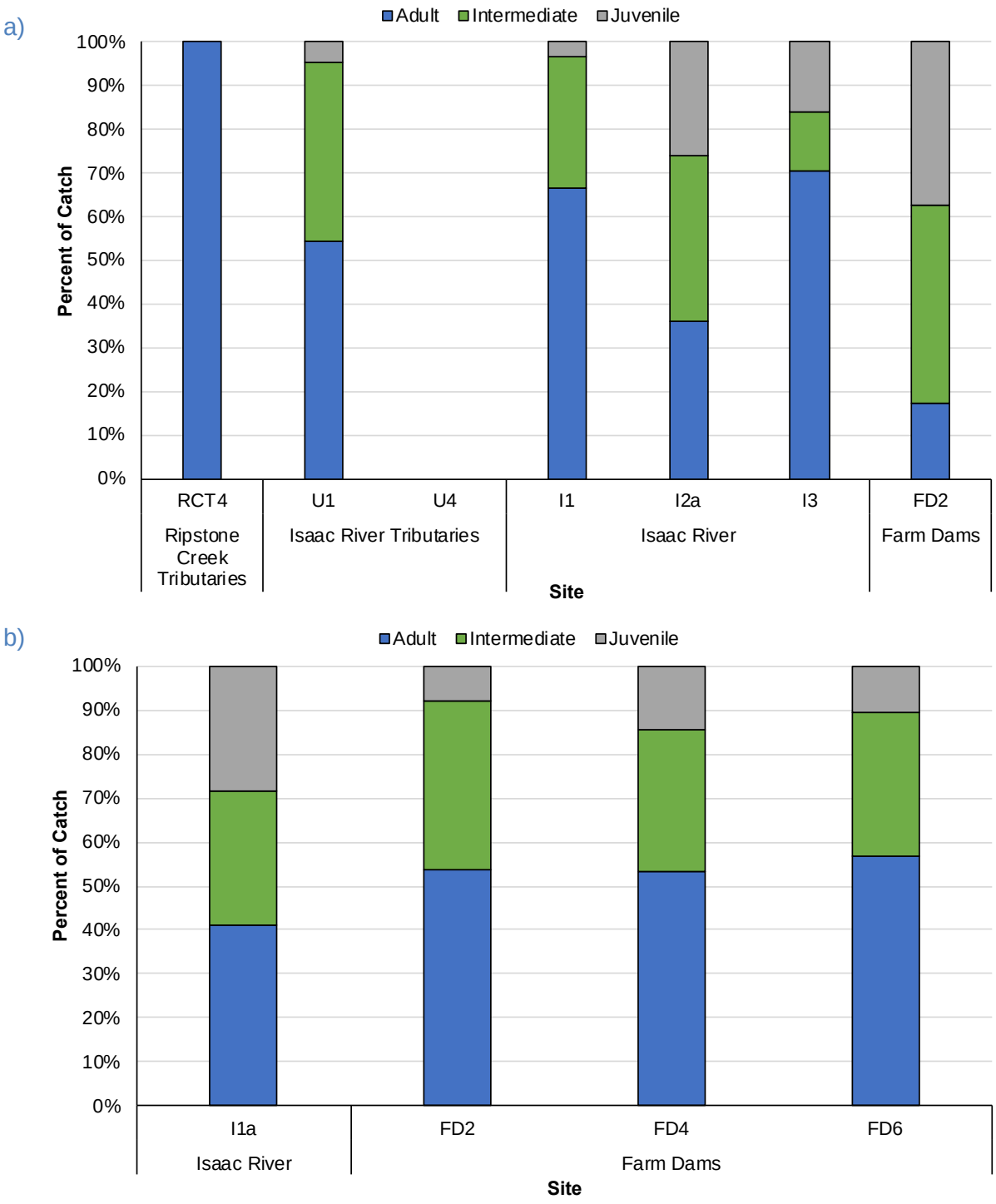


Figure 3.24 Proportion of native fish from juvenile, intermediate and adult life stages caught at sites in a) May 2019, and b) October 2019

Overall, the species (native and pest species) caught in both surveys are known to occur in the region and have been recorded in previous surveys (Table 9.3, Appendix E). The native species recorded have a wide range of habitat preferences (e.g. smaller drainage lines, larger rivers and wetlands) and are tolerant of a range of water quality conditions (pH, salinity and dissolved oxygen concentrations).

Two threatened species of fish listed under the EPBC Act were identified as possibly occurring in the Isaac River sub-basin: Murray cod (*Maccullochella peelii*) and silver perch (*Bidyanus bidyanus*) (DAWE 2020a, DES 2020e, Whitehaven 2019). Neither species was captured during the surveys.

Photos of representative fish from each species are presented in Table 9.4, Appendix E.

3.6.1.1 Pest Species

No exotic species are listed by the DES as occurring in the Isaac River sub-basin (DES 2020b); however, mozambique tilapia (*Oreochromus mossambicus*), mosquitofish (*Gambusia holbrooki*) and platy (*Xiphophorus maculatus*) have been recorded in waterways within the region (in the Isaac River around Moranbah, upstream of the Study area) during previous surveys (Catchment Solutions 2015, DPM Enviros ciences 2018). Tilapia and mosquitofish are restricted noxious fish under the *Biosecurity Act 2014* and platy are a non-indigenous fish that are declared a pest fish when in the wild.

One pest species of fish was recorded in both surveys: mozambique tilapia (Table 3.7). This species is listed as a restricted biosecurity matter and a noxious fish under the *Biosecurity Act 2014*.

In May 2019, mozambique tilapia were caught at all sites on the Isaac River (I1, I2a and I3) but not at any sites within the Project area. In October 2019, tilapia were not caught in the Isaac River at site I1a, but were caught in two of the farm dams (FD2 and FD4).

The abundance of mozambique tilapia was highest at site I3 in May 2019 and contributed to over 35% of the total catch at the site. In October 2019, abundance of tilapia was low at all sites where they were caught (total abundance contributed to <3% of the total catch) (Table 3.7 and Table 3.8).

3.6.2 Turtles

3.6.2.1 Freshwater Turtles

Five species of native freshwater turtles are known to occur in the Isaac River sub-basin (DES 2020b):

- broad-shelled river turtle (*Chelodina expansa*),
- eastern snake-necked turtle (*Chelodina longicollis*),
- Krefft's river turtle (*Emydura macquarii krefftii*),
- white-throated snapping turtle (*Elseya albagula*), and
- Fitzroy River turtle (*Rheodytes leukops*).

The white-throated snapping turtle is listed as critically endangered under the EPBC Act and endangered under the NC Act, while the Fitzroy River turtle is listed as vulnerable under both the EPBC Act and the NC Act. These threatened turtles are discussed further in Section 3.7.2.

Turtles were not particularly abundant or widespread throughout the waterways and wetlands in the vicinity of the Project, which is likely a reflection of the ephemeral nature of the waterbodies where only isolated pools persist year-round and act as refugia for turtles.

Two species of turtles from one family (Chelidae) were recorded across both surveys, including the Krefft's river turtle and the eastern snake-necked turtle (Figure 3.25a and b respectively; Table 3.9). Turtles were only recorded in October 2019, and all individuals caught were adults. Both species are considered widespread and common throughout waterways in Qld. They are known to occur in the region and have been recorded in previous surveys completed on the Isaac River and surrounding waterways and wetlands (DPM Enviroscienses 2018).

Within the Project area, it is considered that the lacustrine wetlands and farm dams would provide the only available habitat for turtles.

a) b)

Figure 3.25 Photographs taken of (a) Krefft's river turtle, and (b) eastern snake-necked turtle

3.6.3 Platypus

Platypus are listed as occurring within the Isaac River sub-basin (DES 2020b). This species is not listed as threatened under the EPBC Act. Platypus are considered to be an iconic species and are protected generally as 'Special Least Concern' under the NC Act.

Platypus populations and habitat are found within the Fitzroy Basin, however, there are no records of platypus from within 30 km of the Project area (ALA 2020; DES 2020f). No platypus or potential habitat for this species were recorded during previous surveys in the vicinity of the Project (frc environmental 2012, DPM Enviroscienses 2018).

No platypus were sighted during the field surveys, and no evidence of platypus (such as burrows) were observed. Overall, given the habitat requirements and distributional range of platypus, it is considered unlikely that the species would occur in the waterways in the vicinity of the Project.

Table 3.9 Turtles recorded during aquatic ecology surveys completed in May and October 2019

Family *Species Name*	Common Name	May-19			Oct-19				
		Isaac River	Farm Dams	*Total – May 19*	Isaac River	Farm Dams			*Total – Oct 19*
		I3	FD2		I1a	FD2	FD4	FD6	
Chelidae									
Chelodina longicollis	eastern snake-necked turtle	0	0	***0***	1	0	2	1	***4***
Emydura macquarii krefftii	Krefft's river turtle	0	0	***0***	0	0	0	1	***1***
	Total	**0**	**0**	***0***	**1**	**0**	**2**	**2**	***5***

3.7 Threatened Species

No listed threatened species of aquatic flora or fauna were recorded during the field surveys or were considered likely to occur in the vicinity of the Project based on known distribution and habitat preferences.

3.7.1 Fish

Although not identified in the EPBC Act *Protected Matters Search Tool* for this study, one listed threatened fish species was identified as potentially occurring within the waterways in the wider Isaac River sub-basin according to the EPBC Act *Protected Matters Search Tool* conducted as part of the Initial Advice Statement (IAS) of the Project (Whitehaven 2019): the Murray cod, listed as vulnerable under the EPBC Act. The Murray cod occurs naturally within the Murray-Darling Basin only; however, translocated populations occur within the Fitzroy Basin due to historical stocking (DAWE 2020b). This species generally inhabits rivers and large tributaries, preferring deep pools and channels with structural complex features such as large rocks, snags, overhanging banks and vegetation, and woody structures (DAWE 2020b). Very little is understood about the distribution of this species throughout the Isaac River sub-basin and there are no known records of it occurring in the vicinity of the Project (ALA 2020, DES 2020f). The Study area does not provide the preferred habitat of this species (i.e. deep channel / pool habitat). This species is not considered further.

One listed threatened fish species was recorded as occurring in the Isaac River sub-basin under the Wetland*Info* database (DES 2020b): silver perch, listed as Critically Endangered under the EPBC Act. The natural distribution of the silver perch is limited to the Murray-Darling Basin and their preferred habitat is fast flowing rivers (DotE 2013c; DAWE 2020c), although it has been frequently translocated across Qld (Pusey et al. 2004). This species was not listed in the *EPBC Act Protected Matters Search Tool Report* (DAWE 2020a) as potentially occurring within 30 km of the Project area, and there are no known records of it occurring in the vicinity of the Project (DES 2020a, DPM Enviros ciences 2018, ALA 2020, frc environmental 2012). The Project area and surrounds does not provide the preferred habitat of this species (i.e. flowing riverine habitat).

3.7.2 Turtles

The Fitzroy River turtle is endemic to the natural, permanent riverine habitats in the middle to lower areas of the Fitzroy River basin in Qld (Limpus et al. 2011, DAWE 2020d) and it has an estimated occurrence in a range of less than 10,000 km^2 (Cogger et al. 1993). This species prefers permanent freshwater riverine reaches (particularly deep pools with rocky, gravelly or sandy substrates, interspersed with areas of riffle habitat) and large, isolated permanent waterholes (Cogger 2000). Preferred areas have high water clarity, and are often associated with ribbonweed (*Vallisneria* sp.) beds (Cogger et al. 1993, DAWE 2020d). Their distribution extends from the Fitzroy Barrage to the upper areas of the Dawson, Nogoa and Connors rivers. Known sites include Boolburra, Gainsford, Glenroy Crossing, Theodore, Baralaba, the Mackenzie River, the Connors River, Duaringa, Marlborough Creek and Gogango (Cogger et al. 1993). Known key sites for the Fitzroy River turtle include Glenroy and Redbank crossings on the Fitzroy River, Theodore Weir on the Dawson River, Cardowan pump pool on the Connors River and Marlborough Creek (Limpus et al. 2011).

The white-throated snapping turtle is endemic to New Guinea and south-eastern Qld, where it occurs in the Fitzroy, Mary and Burnett River basins and associated smaller drainages in south-eastern Qld (Limpus et al. 2011, DAWE 2020e). This species prefers clear, flowing and well oxygenated rivers with sandy-gravel substrate that have suitable shelters and refuges (e.g. submerged rock crevices, undercut banks and/or submerged logs and fallen trees, Limpus et al. 2011). During the day, turtles are affiliated with habitats of high shade (i.e. submerged logs, overhanging riparian vegetation), and at night they inhabit shallow riffles. White-throated snapping turtles are well-adapted for maintaining their position at specific foraging sites in very structured habitats such as log tangles and rocky outcrops with or without currents (Limpus et al. 2011).

Both of these species were listed as potentially occurring within 10 km of the Project area in the *EPBC Act Protected Matters Report* (DAWE 2020a). However, no records of either species are recorded in the vicinity of the Project (ALA 2020, Limpus et al. 2011). The closest known records are from tributaries in the Connors River catchment in the Isaac River sub-basin, approximately 80 km east north-east of the Project area. Therefore, based on desktop review of known distribution and habitat preferences, and field assessments in the dry and wet season surveys, individuals are unlikely to occur in the vicinity of the Project and no core foraging or nesting habitat for these species exists. This conclusion is consistent with results from other recent assessments in the Isaac River catchment (DPM Enviros ciences 2018). These species are not considered further.

3.8 Groundwater-Dependent Ecosystems

GDEs are ecosystems that require access to groundwater to meet all or some of their water requirements on a permanent or intermittent basis for maintenance of the ecosystem (Richardson et al. 2011). GDEs are classified by Doody et.al. (2019) into three broad types:

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

The sub-sections below provide an assessment of the potential occurrence of aquatic GDEs and subterranean GDEs (stygofauna) in the area surrounding the Project. The *Winchester South Project Terrestrial Ecology Assessment* (E2M 2021) provides an assessment of the potential occurrence of terrestrial GDEs in the area surrounding the Project.

3.8.1 Surface-expression GDEs

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

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

The potential occurrence of these aquatic GDEs are discussed below.

Groundwater Dependent Ecosystems Atlas

The *Groundwater Dependent Ecosystems Atlas* (GDE Atlas) (Bureau of Meteorology [BOM] 2019b) provides a model of potential GDEs across Australia based on a national-scale analysis or regional studies. Several aquatic systems within the vicinity of the Project are mapped in the GDE Atlas (BOM 2019b) as low, moderate and high potential for groundwater interaction (Map 7). The GDE Atlas identifies the following potential aquatic GDEs in the vicinity of the Project (Map 7):

- the Isaac River and Cherwell Creek are mapped as having high potential for groundwater interaction,
- wetlands on the Isaac River floodplain and its tributaries are mapped as having high or moderate potential for groundwater interaction, and
- farm dams mapped as having high or moderate potential for groundwater interaction.

The above features are described below.

Isaac River and Cherwell Creek

The Isaac River and Cherwell Creek are ephemeral and only flow briefly after rainfall. As described above, aquatic and riparian ecosystems are classified as aquatic GDEs in or adjacent to streams which are fed by groundwater (Doody et al. 2019).

Data from the Deverill gauging station on the Isaac River indicates surface flow is likely to only occur in the wetter months from November to April, reducing to shallow subsurface flows from May to October (WRM Water & Environment Pty Ltd [WRM] 2021). At the Deverill gauging station, the Isaac River only records flows on 38% of days in a year, with flows above 100 megalitres per day recorded for less than 16% of days of the year. A flow of 100 megalitres per day would not fully inundate the bed of the Isaac River at the Deverill gauging station (WRM 2021).

WRM (2021) describe that the Isaac River stream flows are highly ephemeral with baseflows ceasing within a few days or weeks of a runoff event, or at least flowing below the top of the sandy bed.

The Isaac River and Cherwell Creek are largely a losing system (i.e. not fed by groundwater) resulting in the water draining through the alluvial sediments to the underlying, local groundwater table (SLR 2021). SLR (2021) described that occasional periods of baseflow to the Isaac River from the underlying alluvium may occur after prolonged rainfall events or following flood events. Under these conditions, recharged alluvial sediments would drain to the Isaac River as the hydraulic gradient reverses and sustains stream-flow for a short period after the rainfall event (SLR 2021).

The surface water within the Isaac River is largely fresh, while water within the alluvium is fresh to saline with an average TDS of 863 mg/L and ranging between 10 mg/L to 3,430 mg/L (SLR 2021).

Based on the above, the aquatic in-stream ecosystems associated with the Isaac River and Cherwell Creek are largely not dependent on the surface-expression of groundwater, but would be for a short period after rainfall events. However, these waterways are ephemeral and inevitably dry out.

The surveys found that aquatic habitat condition at Isaac River and Cherwell Creek was representative of ephemeral waterway sites in the broader area (as summarised in Sections 3.1 to 3.7). The field assessment concluded that the aquatic ecological value of these features was low to moderate at waterway sites. Of the four aquatic ecology sites sampled on the Isaac River during the field surveys, all consisted of shallow, isolated pools during the May 2019 survey (excluding site I1a which was not surveyed); and most were dry during the October 2019 survey except for site I1a, which consisted of a shallow, isolated pool. The aquatic ecology site located on Cherwell Creek (i.e. site CK1) was dry during both surveys. Sites previously assessed along Cherwell Creek during aquatic ecology surveys for the Olive Downs Project were also dry (DPM Enviros ciences, 2018).

No inconsistencies in aquatic ecological indicators were observed between waterways mapped by BOM (2020) as potential GDEs compared with those that are not mapped; though the value of sites on the Isaac River and Cherwell Creek was higher than at other riverine sites as these waterways have a higher stream order (and therefore provide greater value in terms of fish passage, connectivity and aquatic habitat availability and quality). No listed aquatic threatened species or communities or their habitat were identified within the Isaac River or Cherwell Creek.

Given the understanding of the groundwater regime described above, the riparian vegetation along the Isaac River and Cherwell Creek may access the surface-expression of groundwater for short periods of time after rainfall events, however monitoring data within the Isaac River indicates that these events would occur infrequently. E2M (2021) has assessed the riparian vegetation as potentially accessing subsurface presence of groundwater (a potential terrestrial GDE). Potential terrestrial GDEs are described further within the *Winchester South Project Terrestrial Ecology Assessment* (E2M 2021).

Wetlands on the Isaac River Floodplain and its Tributaries

There are various wetlands on the Isaac River Floodplain and its tributaries that are mapped as having high or moderate potential for groundwater interaction due to surface-expression of groundwater (i.e. aquatic GDEs) in the GDE Atlas (BOM 2019b) (Map 7).

Four of these wetlands on the Isaac River Floodplain (i.e. the wetlands closest to the Project) were inspected during the aquatic field surveys (sites PW1 to PW4). These wetlands are ephemeral, have limited connectivity to the Isaac River and would only hold water during periods of high rainfall. It should be noted that all four wetlands were dry during May and October 2019 surveys, indicating that these wetlands rely on rainfall, rather than the surface-expression of groundwater.

The depth to groundwater beneath the wetlands ranges from 10 m to 20 m (SLR 2021), meaning that the aquatic ecosystem associated with the wetlands do not receive groundwater discharge, and therefore are not aquatic GDEs. Rather, the clay-rich substrates of these wetlands are likely to hold surface water run-on for extended periods creating the above ground conditions for the aquatic ecosystem. This conclusion is supported by alluvial drillholes and logs and the transient electromagnetic (TEM) survey undertaken in the vicinity of PW2 (the most proximal Palustrine Wetland to the Project), which confirm the presence of clay-rich sediments near the surface (SLR 2021).

In the context of GDEs, the term 'groundwater' includes water occurring naturally below ground level (e.g. in an aquifer), and includes water in the soil capillary zone (capillary fringe above a saturated groundwater zone), but not the water held in the soil above this zone in the unsaturated or vadose zone (Doody et.al. 2019). Therefore, these wetlands do not fit the definition of an aquatic GDE.

E2M (2021) has assessed the riparian vegetation as potentially accessing subsurface presence of groundwater (a potential terrestrial GDE). Potential terrestrial GDEs are described further within the *Winchester South Project Terrestrial Ecology Assessment* (E2M 2021).

Farm Dams

There are several farm dams that are mapped as having high or moderate potential for groundwater interaction due to surface-expression of groundwater (i.e. aquatic GDEs) in the GDE Atlas (BOM, 2019b) (Map 7).

Three of these sites are located within the Project area (LW1 to LW3), LW5 is located 2.5 km downstream of the Project. All of these sites were characterised as man-made dams, either for agriculture/stock watering. All sites were characterised as having poor in-stream and riparian condition with significant existing impacts associated with:

- alteration of habitat to construct the dams,
- reduced riparian vegetation as a result of land clearing, and
- disturbance to bank stability and instream habitat from cattle access.

Of the three lacustrine wetlands that were mapped as having low and high potential for groundwater influence, two were dry in October 2019 (i.e. LW1 and LW2), and one consisted of a small shallow pool (i.e. LW3).

The depth to groundwater beneath the dams is typically 20 to 30 m (10 m in the vicinity of LW5 east of the Project) (Map 7). Therefore, the waterbodies in these dams are not considered to be groundwater dependent. Further, the farm dams within the Project area would be cleared for the Project so are not discussed further in the context of GDEs, rather the clearance impacts are discussed in Section 5.

Conclusion

In conclusion, the aquatic in-stream ecosystems associated with the Isaac River and Cherwell Creek are largely not dependent on the surface-expression of groundwater, but would access groundwater for a short period after rainfall events. The wetlands and farm dams in the locality are not likely to be aquatic GDEs.

Potential terrestrial GDEs associated with riverine and wetland systems are described further within the *Winchester South Project Terrestrial Ecology Assessment* (E2M 2021).

3.8.2 Subterranean GDEs

The results of the stygofauna assessment are presented in Section 4.

3.9 Matters of State Environmental Significance

There are eleven MSES namely:

- regulated vegetation,
- connectivity areas,
- wetlands and watercourses (including WPA, HEV waters and HES wetlands),
- designated precincts in strategic environmental areas,
- protected wildlife habitat,
- protected areas,
- highly protected zones of State marine parks,
- Fish Habitat Areas[2],
- waterways providing for fish passage,
- marine plants, and
- legally secured offset areas.

Several MSES are relevant to freshwater aquatic ecology, including:

- wetlands and watercourses,
- protected wildlife habitat, and
- waterways providing for fish passage.

These matters are discussed in more detail in the sections below.

3.9.1 Wetlands and Watercourses

No wetlands and watercourses that are MSES are present in the Project area.

There is one HES palustrine wetland (also a WPA) mapped approximately 4 km east and 5 km downstream of the Project area in the Isaac River floodplain. Based on the results of the field surveys, this wetland was in moderate condition and was assessed as having similar aquatic ecological value to most other palustrine wetlands in the vicinity of the Project. Aquatic habitat condition at this wetland is discussed in detail in Section 3.1.2.1.

3.9.2 Protected Wildlife Habitat

No threatened aquatic species listed under the NC Act or their habitat were recorded during the field surveys and they are considered unlikely to occur due to habitat requirements and / or distributional range.

[2] The closest Fish Habitat Area downstream of the Project is the Fitzroy River Fish Habitat Area near Rockhampton, more than 250 km from the Project (direct distance); therefore, Fish Habitat Areas will not be impacted by the Project and are not considered further.

3.9.3 Waterways Providing for Fish Passage

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

Waterway barrier works are defined under the *Fisheries Act 1994* as any dam, weir or other barrier across a waterway if the barrier limits fish stock access and movement along the waterway. The *Queensland Waterways for Waterway Barrier Works* (DAF 2020) spatial layer indicates the level of 'risk' associated with undertaking waterway barrier works within Qld waterways with regards to fish passage (Map 10).

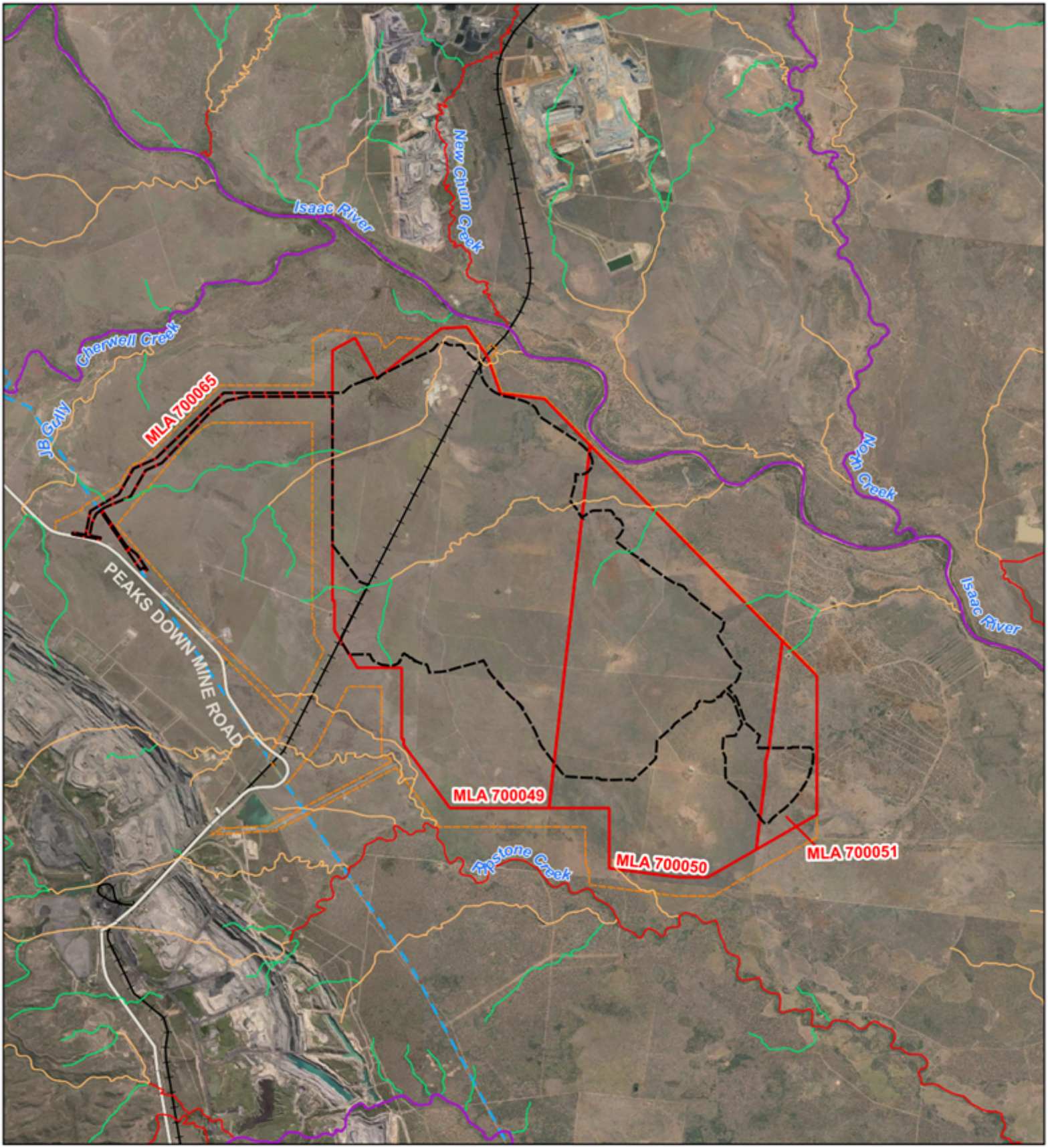
Where the works associated with the Project are undertaken on the mining lease under the conditions of an Environmental Authority (and not a development approval), a waterway barrier works approval under the *Planning Act 2016* will not be required; however, fish passage requirements need to be considered in relation to the MSES.

The Project would impact (remove) waterways (unnamed tributaries) that are mapped as moderate risk (amber) or low risk (green) (Map 10), however the Project would not create a barrier to fish passage to any high (red) or major (purple) risk waterways, as further described in Section 5.2.

3.10 Matters of National Environmental Significance

As described in Section 1.1, a delegate of the Commonwealth Minister determined the following controlling provisions apply for each action under the EPBC Act:

1. Winchester South Project Mine Site and Access Road (EPBC 2019/8460) (Map 11)
    a. listed threatened species and communities (sections 18 and 18A), and
    b. a water resource, in relation to coal seam gas development and large coal mining development (sections 24D and 24E).
2. Winchester South Project Water Pipeline (EPBC 2019/8459) (Map 11)
    a. listed threatened species and communities (sections 18 and 18A).
3. Winchester South Project Electricity Transmission Line (EPBC 2019/8458) (Map 11)
    a. listed threatened species and communities (sections 18 and 18A).



Legend

- Indicative surface disturbance extent
- Winchester South MLA
- Primary study area
- Roads
- Railway
- Eungella Pipeline

Waterways for Waterway Barrier Works Mapping

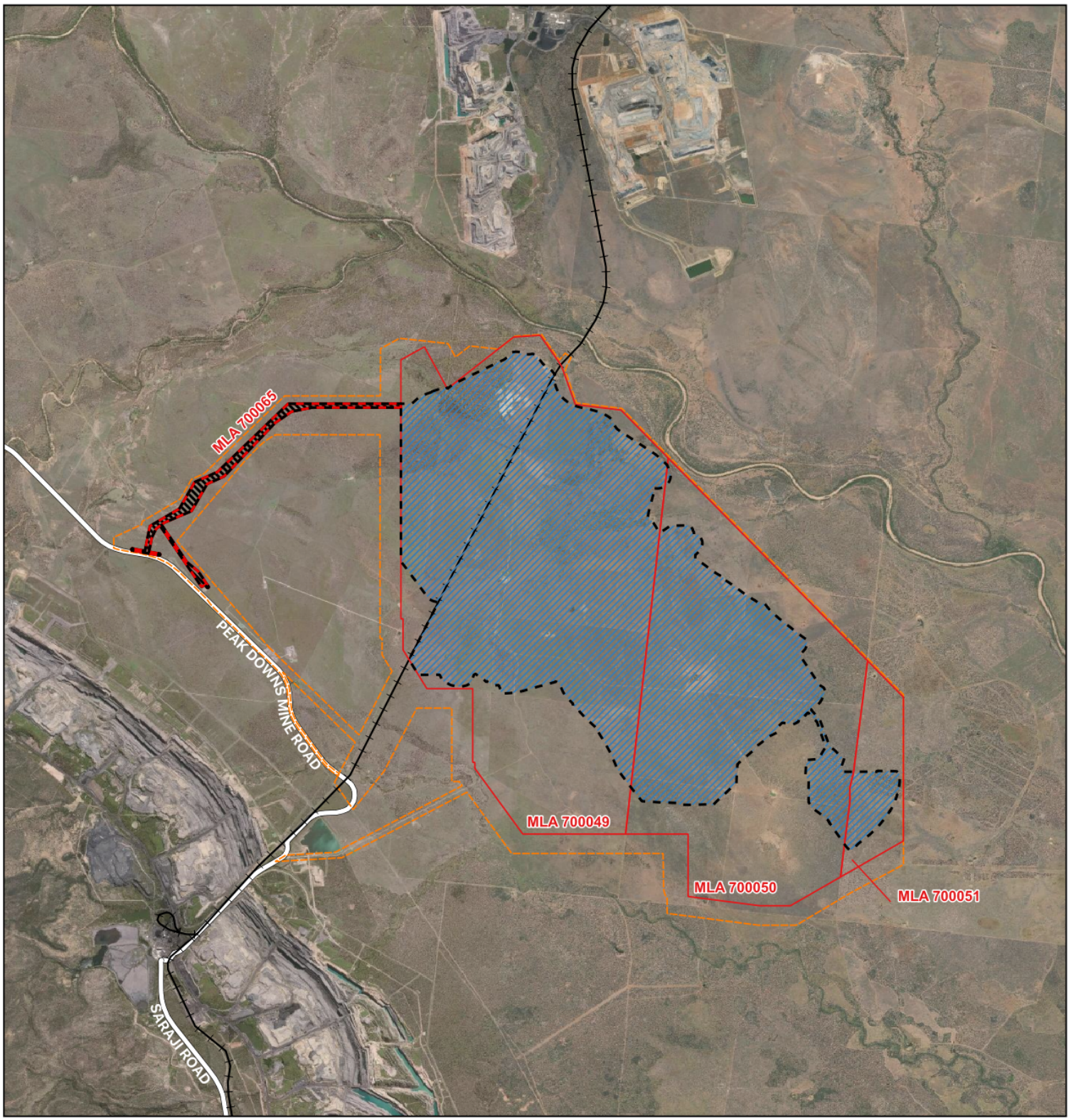
Grade of Impact

- Low
- Moderate
- High
- Major

Map 10: Waterway Barrier Works Mapping as per the Fisheries Act, 1994 in the Vicinity of the Project

Project Number: 1845
Author: SLG
Date: 07 May 2021
Datum: GDA94
Data Sources:
© DAF 2020a; DES 2020a; DNRME 2020a; DNRME 2020b; DNRME 2020c; DNRME 2020d; DNRME 2020h; DTMR 2020; Esri 2020

0 1 2 3 4 5 6 km



Legend

- Indicative surface disturbance extent
- Winchester South MLA
- Primary study area
- Road
- Railway

EPBC footprint

- Winchester South Project Mine Site and Access Road (EPBC 2019/8460)
- Infrastructure corridor Access road (EPBC 2019/8460), water pipeline (EPBC 2019/8460) and ETL (EPBC 2019/8458)

Map 11: Footprint of each controlled action under the EPBC Act

Project Number: 1845
Author: JK
Date: 02 November 2020
Datum: GDA94
Data Sources:
© DTMR 2020; Esri 2020

0 1 2 3 4 km

3.10.1 Listed Threatened Species and Communities

No threatened aquatic species listed under the EPBC Act or their habitat was recorded during the field surveys, and they are considered unlikely to occur due to habitat requirements and / or distributional range. No threatened aquatic ecological communities were present within the Project area or surrounds.

3.10.2 Water Resources

Water resources were recorded during the field surveys and are shown on Map 6, Map 7 and Map 9, including:

- waterways (all of which were ephemeral or intermittent in nature; see Section 3.1.3),
- lacustrine wetlands/farm dams (all of which were characterised as man-made dams, either for agriculture/stock watering or mine water management; see Section 3.1.1),
- palustrine wetlands (all of which were dry during the field surveys; see Section 3.1.2), and
- mapped potential aquatic (i.e. surface-expression) GDEs (see Section 3.8).

4 Stygofauna Results

4.1 Field Survey Results

4.1.1 In-Situ Water Quality

Water quality can be an important determinant in the presence and abundance of stygofauna. Stygofauna are typically most likely to occur where EC is less than 5,000 microSiemens per centimetre (µS/cm) (Doody et al. 2019). Although stygofauna have been collected from aquifers with EC of up to 56,000 µS/cm, the diversity and abundance of stygofauna typically decreases with increasing EC above 5,000 µS/cm (Hancock & Boulton 2008, Watts & Humphreys 2009, Schulz et al. 2013, Glanville et al. 2016). They can also tolerate a pH range of 3.5 to 10.3, but a higher diversity is likely to occur in aquifers with a pH range of 6.5 to 7.5 (4T 2012).

The occurrence of stygofauna communities within the Bowen Basin is poorly understood. A previous review of stygofauna studies in the Bowen Basin concluded that stygofauna are rare or unlikely to occur within the bedrock (4T 2012). However, they are considered likely to occur in some of the unconsolidated sandy sediments associated with the Isaac River floodplain due to the high porosity, suitable hydraulic conductivity and interconnectivity. In alluvial sediments, stygofauna are typically found in shallow depths (<20 m) and at EC levels of less than 2,000 µS/cm, though they still may occur outside of this range (4T 2012).

EC and pH of groundwater was within the range known to support stygofauna at all bores. in-situ measurements recorded during field sampling showed that groundwater was close to neutral at all bores (with pH ranging from 6.55 to 7.74) (Table 4.1). EC varied substantially throughout the Study area (ranging from 942 µS/cm to 28,069 µS/cm).

Table 4.1 In-situ water quality recorded at each bore during the pilot study

Bore ID	May-19		Oct-19		Jan-20	
	pH [a]	EC (µS/cm) [b]	pH [a]	EC [b]	pH [a]	EC (µS/cm) [b]
Wynette Bore	–	–	6.62	2,724	6.94	2,817
Knob Hill 2	–	–	6.81	942	6.76	966
C2136	6.82	12,977	–	–	6.78	15,783
R2009	7.18	4,185	–	–	7.30	4,416
R2010	6.86	7,401	–	–	6.72	28,069
R2032	6.65	11,404	–	–	7.14	11,567
R2035	7.00	4,731	–	–	7.45	4,757
R2054	6.66	7,907	–	–	7.16	8,121
R2055	6.55	7985	–	–	6.85	8,374
Knob Hill 1	–	–	–	–	6.77	7,842
R2008	–	–	–	–	7.74	11,803

[a] pH measured in pH units
[b] EC measured in µS/cm
– not sampled

4.1.2 Stygofauna Communities

No stygofauna specimens were recorded from bores sampled during the field survey.

The regolith is considered to be largely unsaturated throughout the region, with the presence of highly saline water occurring in the lower elevation areas along the Isaac River and the lower reaches of its tributaries (such as Ripstone Creek) (DPM Enviros ciences 2018). The high EC of the regolith throughout the broader region suggests that the groundwater environment is not ideal for stygofauna; however, stygofauna are likely to occur in the alluvium associated with the Isaac River (DPM Enviros ciences 2018).

Two bores in the Isaac River alluvium were sampled recently as part of a stygofauna pilot study completed for the Olive Downs Project EIS (DPM Enviros ciences 2018). Although stygofauna were considered likely to occur in these unconsolidated sediments, none were recorded during the study.

A recent stygofauna pilot study prepared for the Isaac Downs Project (located approximately 13 km north of the Project) (frc environmental 2019), that included surveys of bores adjacent to the Isaac River, found two stygofauna specimens of the Orders Copepoda (copepod) and Nematoda (worm) in a single bore. A recent stygofauna pilot study prepared for the Vulcan Complex Project (located approximately 10 km south-west of the Project) (frc environmental 2020) found one stygofauna specimen of the Order Ostracoda (seed shrimp) in each of two bores. However, copepods, ostracods and nematodes are stygoxenic fauna, meaning they are aquatic fauna that will use groundwater ecosystems, but they are not dependent on groundwater to complete their lifecycle; that is, they are not obligate inhabitants of groundwater ecosystems and are unable to establish populations in such environments (frc environmental 2019 2020).

5 Impact Assessment

This section summarises the potential impacts of the Project on aquatic ecology in accordance the *EIS Information Guideline – Aquatic Ecology* (DEHP 2019a) and *EIS Information Guideline – Groundwater Dependent Ecosystems* (DEHP 2019b).

5.1 Aquatic Habitat Clearance and Modification

Progressive vegetation and soil clearing would be undertaken ahead of the advancing open cut mining operation. The Project would remove the following aquatic habitat (Map 3 and 10):

- portions of three unnamed waterways (tributaries to the Isaac River) that traverse the open cut extent and waste rock emplacement:
    - the upper reaches of a minor stream order 1 waterway in the waste rock emplacement area that is north of Main Pit South,
    - the middle reaches of a stream order 2 waterway and the majority of the headwaters of this waterway (two stream order 1 tributaries) in the Main Pit, North and West Pit, and associated waste rock emplacement areas; the Eagle Downs Mine is located in the upper catchment of these waterways,
    - the middle reaches of a stream order 2 waterway in the Railway Pit and associated waste rock emplacement areas; tributaries to this waterway are within the Eagle Downs Mine, and
- seven farm dams (three of which are mapped by the State as lacustrine wetlands) in various locations within the Project area[3], and
- one palustrine wetland RE, as mapped by E2M (2021).

There would be a reduction in habitat available to aquatic flora and fauna as a result of the removal of the portions of three unnamed waterways and farm dams within the Project area. The palustrine wetland RE contained wetland indicator species (such as sedges) in the understorey, but is unlikely to provide important habitat for aquatic fauna due to a lack of connectivity with surrounding waterways. These habitats are common and typical of the region and the Project is not expected to significantly impact aquatic ecology on a regional scale.

The unnamed waterways are ephemeral and the integrity of these aquatic systems has been impacted by agricultural land uses (vegetation clearing, creation of dams and direct impacts from cattle). The waterways to be impacted provide low aquatic ecosystem value to aquatic flora and fauna. During the field surveys, these waterways consisted of either isolated pools or were dry and were poorly connected (i.e. would only connect to habitats upstream and downstream during periods of high flow, with connectivity impaired by the presence of on-stream farm dams). Approximately 15.7 km of the unnamed waterways would be cleared. The upstream catchment of these waterways (which is within the Eagle Downs Mine area) would be diverted around the Project area.

[3] All of the mapped lacustrine wetlands and unmapped dams within the Project area were characterised as man-made dams (Section 3.1).

The farm dams that would be cleared provide low to moderate aquatic ecosystem value to aquatic flora and fauna, although some of these farm dams provided dry season refuges for aquatic flora and fauna. Farm dams were poorly connected to upstream and downstream habitats due to the ephemeral nature of the waterways (which would only connect and flow during periods of high rainfall) and the presence of high dam walls. The seven farm dams cover an estimated total area of approximately 10 ha.

All aquatic flora and fauna species detected in the vicinity of the Project during the field surveys were common to the region, and none were listed threatened species under the NC Act or EPBC Act. Therefore, their removal would not have a significant impact on a regional scale.

5.2 Fish Passage

The Project would result in the removal of portions of unnamed waterways (as discussed in Section 5.1); however, the impact to fish passage is considered insignificant and unlikely to have a measurable impact to aquatic ecology beyond the Project area.

These three ephemeral waterways within the Project area are classified as low and moderate risk of adverse impacts to fish movements. Based on the results of the field survey, these waterways provide poor aquatic ecological value and are largely disturbed by surrounding land use. They are low Strahler stream-order waterways that do not connect to important fish habitat upstream. Furthermore, the reaches of these waterways upstream of the Project are within the Eagle Downs Mine area.

Overall, connectivity through the waterways and wetlands within and upstream of the Project area is currently very limited due to the ephemeral nature of the area, and there are no important breeding, feeding or refuge areas to consider (e.g. for threatened or priority species). Species that are found within the Project area (and any species that may potentially occur in the farm dams upstream of the Project area) are common within the region and resilient and have likely established self-sustaining communities that are not reliant on connections through the Project area to other waterways.

Waterways that provide for fish passage under the *Fisheries Act 1994* are discussed in Section 3.9.3.

5.3 Surface Water Quality

The risk of elevated, suspended and dissolved solids and other contaminants impacting downstream waters is considered to be low with appropriate mitigation and management strategies, such as implementation of an Erosion and Sediment Control Plan, appropriate management of hazardous chemicals and materials, and implementation of water quality monitoring programs during construction and operation of the Project (refer Section 6) (WRM 2021). If implemented effectively, run-off from surface disturbance areas would not pose a significant environmental risk on receiving water quality (WRM 2021). Given the above, no adverse impacts to the aquatic ecological values of the receiving environment are expected as a result of increased suspended or dissolved sediment loads or chronic exposure to contaminants.

Further details regarding the hydrological processes in the vicinity of the Project, including detailed review of water quality monitoring data from existing regional and local surface water monitoring sites, are provided in the *Winchester South Project Surface Water and Flooding Assessment* (WRM 2021) and *Geomorphology Assessment* (Fluvial Systems Pty Ltd [Fluvial Systems] 2020).

5.4 Mine-affected Water Controlled Discharges

The *Surface Water and Flooding Assessment* (WRM 2021) for the Project, supported by site water balance modelling, concluded that:

- no uncontrolled overflows of mine-affected water from water storages and dams are predicted,
- some overflow of water from sediment dams (designed in accordance with the *Best Practice Erosion and Sediment Control* guideline [International Erosion Control Association Australasia (IECA) 2008]) would occur when rainfall exceeds the design standard; however the salinity of the sediment dam overflows would have a negligible impact on the quality of the Isaac River, and
- there is a predicted negligible impact on the downstream water quality through controlled releases from the Project.

Given the above, no adverse impacts to the aquatic ecological values of the receiving environment as a result of exposure to contaminants in mine-affected water are expected. Further details regarding the release of mine-affected water are provided in the *Surface Water and Flooding Assessment* (WRM 2021).

5.5 Leaks and Spills

Leaks and spills of hydrocarbons and other chemicals and contaminants can directly impact water quality. This can have both direct (e.g. toxicity) and indirect (e.g. changes to habitat characteristics and condition) influences on aquatic flora and fauna. However, where effective mitigation and management measures are in place, including management of hazardous chemicals and materials in accordance with Qld and Commonwealth legislation or policy requirements (refer Section 6.4), the risk to the aquatic ecological values of the receiving environment is low.

5.6 Seepage

The *Geochemical Assessment of Potential Waste Rock and Coal Reject Materials* (Terrenus Earth Sciences 2020) concluded that the majority of the overburden and interburden generated from the Project would generally be expected to have a low sulfur content and be non-acid forming (NAF). Therefore, the risk of impacts to aquatic ecosystems is expected to be low.

5.7 Loss of Catchment Area and Changes to Flow Regimes

The Project area represents less than 0.05% and 0.3% of the overall catchment areas for the Fitzroy River basin and the Isaac-Connors sub-basin, respectively. The changed topography as a result of the Project final landform would reduce the catchment area draining to the Isaac River compared to pre-mining conditions; however, the decrease in catchment area is expected to be less than 1.5% (WRM 2021). No measurable impacts to surface water quantity are likely to occur as a result of the Project (WRM 2021). Therefore, the loss of catchment area is minor in a regional context.

Regardless of this change to the captured catchment area, no measurable impacts to surface water quantity are likely to occur as a result of the Project (WRM 2021). Furthermore, modelling has shown that the Project will result in negligible increased leakage from surface flows of the Isaac River to the underlying alluvium, with the change in flows as a result of the increased hydraulic gradient between the alluvium and the Isaac River expected to be an average of 3.65 megalitres per year (ML/year) (SLR 2021). Therefore, impacts to surface flows and subsequently aquatic ecosystems downstream of the Project area are not expected.

5.8 Controlled Releases

The Project would not significantly impact on the existing and approved flooding conditions for the Isaac River, and therefore it is not expected that there would be impacts on aquatic flora or fauna.

5.9 Flood Regimes

Impacts to aquatic flora and fauna are not likely to be significant in the context of impacts that already occur during significant flood events. The temporary flood levees would be progressively constructed as required to provide protection to Project operations. The temporary flood levees would be constructed to the north of the Railway Pit, and to the north-east of the Main Pit, to prevent inundation of the open cut during operations. The width and geometry of the temporary flood levees would be determined during detailed design of the Project, but would be such that they would be stable under extreme flow conditions. The temporary flood levees located to the north of the Railway Pit and the north-east of the Main Pit, respectively, would be removed once they are no longer required.

5.10 Litter and Waste

Litter and waste associated with vehicle maintenance and mining operations would be managed so as not to pose a risk to aquatic ecology.

5.11 Introduction and Proliferation of Invasive Species

One species of invasive fish (mozambique tilapia) was recorded as part of the field surveys. This species is known to occur in the broader region of the Isaac River sub-basin. No invasive aquatic plants were recorded during the field surveys. The Project would not result in additional habitat for invasive fish.

The Project is unlikely to result in the addition of new invasive species of aquatic flora or fauna because it does not involve diversion of waterways into adjacent catchments. Any pest fish species caught during salvage of fauna in farm dams within the Project area will be ethically euthanized, and will not be translocated to nearby waterways with native fish.

Potential impacts from terrestrial weed species are discussed in the Terrestrial Ecology Assessment (E2M 2021).

5.12 Groundwater-Dependent Ecosystems

5.12.1 Aquatic GDEs

As described in Section 3.8.1, the aquatic in-stream ecosystems associated with the Isaac River and Cherwell Creek are largely not dependent on the surface-expression of groundwater, but would be for a short period after rainfall events. The wetlands and farm dams in the locality are not likely to be aquatic GDEs.

Modelling has shown that the Project would result in negligible increased leakage from surface flows of the Isaac River to the underlying alluvium, with the change in flows as a result of the increased hydraulic gradient between the alluvium and the Isaac River expected to be an average of 3.65 ML/year (when the Isaac River flows, an average flow rate of 161,863 ML/year is observed) (SLR 2021). Therefore, impacts to surface flows and subsequently aquatic ecosystems downstream of the Project area are not expected.

The Project is unlikely to result in any noticeable changes to baseflow contributions to Cherwell Creek, New Chum Creek and North Creek or Cherwell Creek given the distance of these waterways from the Project area (SLR 2021).

5.12.2 Stygofauna

The stygofauna pilot study was designed to detect stygofauna if present in the Project area or surrounds in accordance with the *Guideline for the Environmental Assessment of Subterranean Aquatic Fauna* (DES 2015). No stygofauna were recorded during this study, which was not unexpected, as no stygofauna were found nearby during the sampling for the Olive Downs Project by DPM Enviroscienses (2018). No obligate stygofauna taxa were recorded during surveys during 2019 and 2020 during sampling at other sites in the region (for the Isaac Downs and Vulcan Projects) by frc environmental (2019, 2020).

Given that no stygofauna were recorded during the pilot study for this Project, no further surveys are required under the *Guideline for the Environmental Assessment of Subterranean Aquatic Fauna* (DES 2015).

Based on a desktop review, the most likely potential habitat for stygofauna is the unconsolidated sediments associated with the Isaac River alluvium (to the east of the Project). Although no stygofauna were recorded during the pilot study, the potential impacts on the Isaac River alluvium (potential stygofauna habitat) are discussed below.

The main potential impact on the Isaac River alluvium (potential stygofauna habitat) is groundwater drawdown. However, the groundwater drawdown would be localised and the total area of the Isaac River alluvium extends along the length of the Isaac River beyond the areas potentially affected by drawdown.

The incremental groundwater drawdown predictions modelled by SLR (2021) indicate that there would be no drawdown greater than 0.3 m in the Isaac River alluvium. Therefore, there would be no impacts on the Isaac River alluvium due to the Project.

Given the predicted impacts on the Isaac River alluvium would be localised and temporary, it is considered unlikely that the Project would result in a significant impact to any stygofauna communities (if they were likely to occur).

5.13 Final Landform

An up-catchment diversion system would be progressively constructed as part of the Project, to divert up-catchment run-off around the advancing open cut during operation (Map 12). Once land becomes available, a permanent diversion would be constructed and integrated into the final landform for the Project to allow flows to the Isaac River in perpetuity.

Seepage from in-pit emplacements associated with the Project is not expected to migrate to the surrounding alluvium, as the groundwater level that would ultimately equilibrate within the waste rock emplacements would be below the base of the alluvium (SLR 2021).

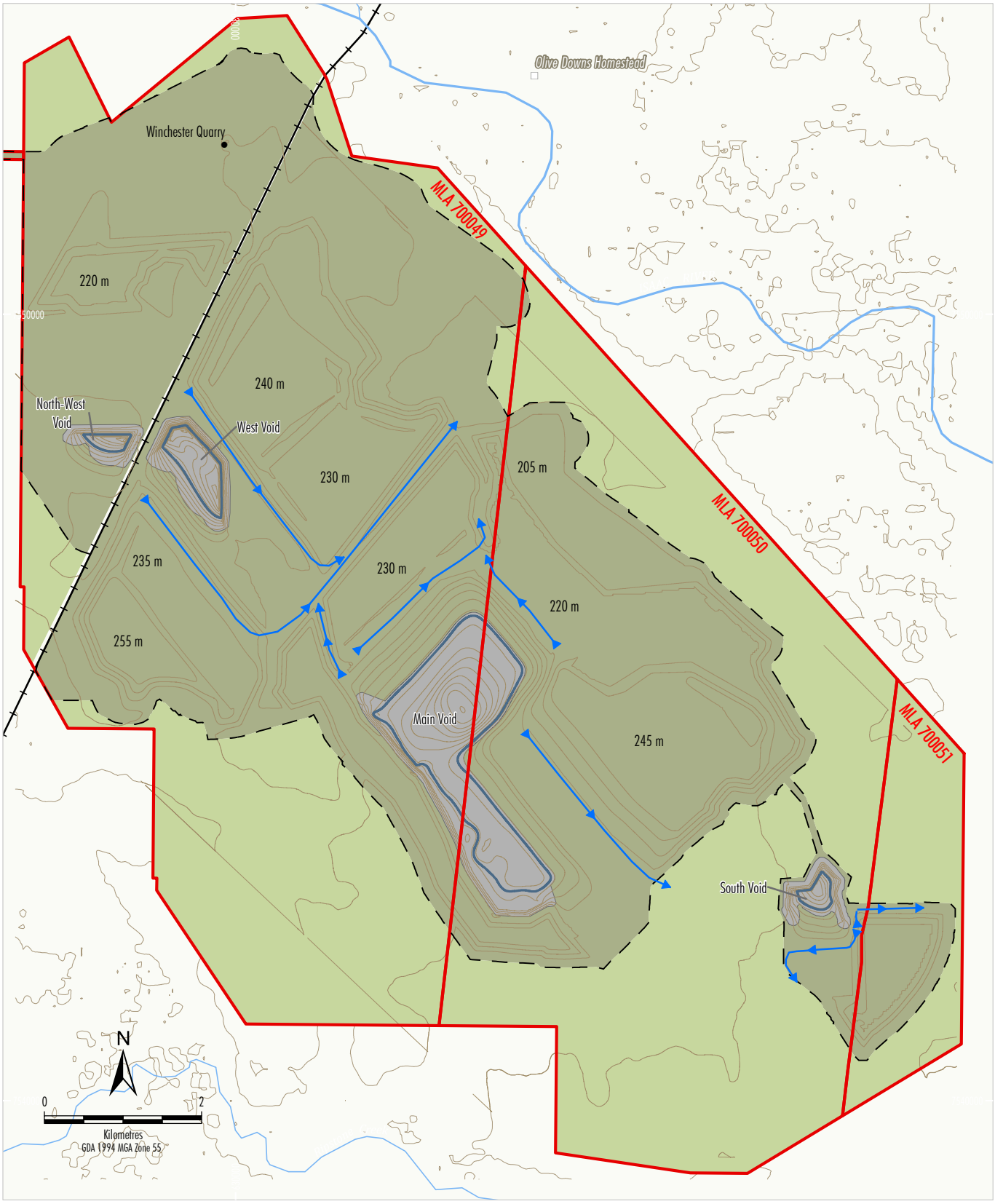
Four final voids are proposed within the Project area to remain in perpetuity. Modelling predicted that the final void water levels would equilibrate to (WRM 2021, SLR 2021):

- 162 mAHD in the North-west Pit Void.
- 128 mAHD in the West Pit Void.
- 164 mAHD in the Main Pit Void.
- 142 mAHD in the South Pit Void.

Water within final voids would evaporate from the final void water body and draw in groundwater from the surrounding strata and rainfall runoff from the final void catchment areas. As the final voids would act as sinks, evaporation from the final void water body would overtime concentrate salts in the final void water body (SLR 2021). However, the gradual increase in salinity of the final void water body would not pose a risk to the surrounding groundwater regime as the final voids would remain as groundwater sinks in perpetuity (SLR 2021). Given the final voids would be sinks, they are not expected to result in any adverse groundwater quality impacts.

5.14 Cumulative Impacts

The Surface Water and Flooding Assessment (WRM 2021) and Groundwater Assessment (SLR 2021) concluded that the Project would have a negligible impact on surface water and groundwater quality and quantity, including the Isaac River (WRM 2021, SLR 2021). The modelling undertaken included consideration of cumulative impacts from surrounding developments, and are described in the Surface Water and Flooding and Groundwater Assessments. Given the above, the Project is unlikely to adversely impact the aquatic ecological values of these waterways. The Project is therefore unlikely to result in cumulative impacts to the aquatic ecosystem resilience or aquatic flora and fauna of the Isaac River system, including floodplain wetlands, given the limited potential impacts associated with the Project and the mitigation and management measures summarised in Section 6.



LEGEND

- Mining Lease Application Boundary
- Indicative Surface Disturbance Extent
- Indicative Residual Void Lake
- Indicative Extent of Non-Use Management Area
- Indicative Extent of Rehabilitation to Low-Intensity Grazing Post-Mining Land Use*
- Land Outside Indicative Surface Disturbance Extent with a Low-Intensity Grazing Post-Mining Land Use
- Contours (10 m)
- Indicative Surface Water Drain

*Note: * Should the Winchester Quarry remain at the end of the Project life, the PMLU for its extent would be quarrying and not low-intensity grazing.*

Source: The State of Queensland (2018 - 2020); Whitehaven (2020).

WHITEHAVEN COAL

WINCHESTER SOUTH PROJECT

Conceptual Final Landform

Map 12

5.15 Impacts on Matters of National Environmental Significance

5.15.1 Mine Site and Access Road (EPBC 2019/8460)

Listed threatened species and communities, and water resources in relation to coal seam gas development and large coal mining development were listed as controlling provisions for the mine site and access road. Waterways, wetlands and farm dams of low to moderate aquatic ecological value are present within the mine site area. The mine access road also crosses an unnamed tributary of the Isaac River (i.e. site U3a) which is of low aquatic ecological value.

As discussed in Section 3.7, no aquatic threatened species listed under the EPBC Act or their habitat was recorded during field surveys, and they are considered unlikely to occur due to habitat requirements and/or distributional range. No ecological communities relevant to aquatic ecology were present. Therefore, no significant impacts to threatened species or ecological communities are expected as a result of the development of the mine site and access road. As such, a specific assessment of impacts to listed aquatic threatened species and communities under the *Matters of National Environmental Significance: Significant Impact Guidelines 1.1* (DotE 2013a) is not required.

As described in Section 5.1, all waterways, wetlands and dams in the footprint of the mine site and access road are of low to moderate aquatic ecological value, with no significant core habitat for aquatic species present. The loss or modification of these habitats is unlikely to have an impact of aquatic ecology on a regional scale. As described in Sections 5.3 to 5.14, the impacts to hydrology, including the interface between surface water and groundwater, and water quality as a result of the Project are predicted to be negligible, particularly where mitigation and management measures are implemented. As such, no significant impacts to aquatic ecosystem function as a result of the Project are expected. Therefore, no significant impacts to water-dependent ecosystems, in accordance with the criteria outlined in the *Significant Impact Guidelines 1.3: Coal Seam Gas and Large Coal Mining Developments – Impacts on Water Resources* (DotE 2013b), are expected.

5.15.2 Water Pipeline (EPBC 2019/8459)

No aquatic habitat is present along the proposed water pipeline. No habitat for threatened aquatic species or ecological communities listed under the EPBC Act was present in the surrounds, and they are considered highly unlikely to occur due to the availability and condition of habitat. Therefore, no impacts to aquatic MNES are expected as a result of the construction or operation of the water pipeline, and a specific assessment of impacts to listed aquatic threatened species and communities under the *Matters of National Environmental Significance: Significant Impact Guidelines 1.1* (DotE 2013a) is not required.

5.15.3 Electricity Transmission Line (EPBC 2019/8458)

No aquatic habitat is present along the proposed ETL. No habitat for threatened aquatic species or ecological communities listed under the EPBC Act was present in the surrounds, and they are considered highly unlikely to occur due to the availability and condition of habitat at the crossing locations. Therefore, no impacts to aquatic MNES are expected as a result of the construction or operation of the ETL, and a specific assessment of impacts to listed aquatic threatened species and communities under the *Matters of National Environmental Significance: Significant Impact Guidelines 1.1* (DotE 2013a) is not required.

5.16 Impacts on Matters of State Environmental Significance

No HES wetlands are present within the Project area. There is one HES palustrine wetland (also a WPA) mapped approximately 4 km east and downstream of the Project area in the Isaac River floodplain (Map 3). This wetland was in moderate condition and was dry during the field surveys. It was also assessed as having similar aquatic ecological value to most other palustrine wetlands in the vicinity of the Project area. Although this wetland would rarely be inundated, any changes in water quality or flood regimes in the Isaac River as a result of the Project could indirectly impact the values of this wetland. However, such impacts are likely to be minimal, particularly where management and mitigation measures are adopted to control these potential impacts, as described in Section 6. As such, it is considered unlikely that there would be measurable impacts to the aquatic ecological value of this wetland.

No threatened aquatic species listed under the NC Act or their habitat was recorded during the field surveys, and they are considered unlikely to occur due to habitat requirements and / or distributional range. Therefore, no significant impacts to threatened species are expected as a result of the Project.

In regard to waterways that provide for fish passage under the *Fisheries Act 1994*, any part of a waterway providing for passage of a fish is a MSES only if the construction, installation or modification of waterway barrier works carried out under an authority will limit the passage of fish along the waterway. The waterways in the Project area are mapped as having low and moderate impact to fish passage in the *Waterway Barrier Works* mapping layer (Map 10). Potential impacts to fish passage have been assessed in accordance with the *Queensland Environmental Offsets Policy – Significant Residual Impact Guideline* (DEHP, 2014) and are considered likely to be insignificant. Assessment of impacts on fish passage are discussed in detail in Section 5.2. Loss of these drainage features (mapped as waterways by DAF) is also likely to have a negligible impact of aquatic ecosystems in a regional context, as discussed in Section 5.1.

6 Impact Avoidance and Mitigation Measures

Measures to avoid and mitigate impacts on aquatic ecology are described below.

6.1 Impact Avoidance Measures

The following refinements to the mine design have resulted in avoiding impacts on aquatic ecology:

- minimising the overall mine footprint by optimising the backfilling of the open cut,
- avoiding clearing of riparian vegetation associated with the Isaac River,
- avoiding creek crossings/waterways for the infrastructure corridor, and
- avoiding palustrine wetlands to the north-east of the Project and establishing a 50 m buffer inside the MLAs on two of the wetlands (PW2 and PW3).

6.2 Management of Palustrine Wetlands

During the life of the Project, cattle would be excluded from two palustrine wetlands (PW2 and PW3) to the north of the Project (within the 50 m buffer inside the MLAs) (Map 9). These two palustrine wetlands are located on privately-owned land (PW2) and on land owned by Whitehaven WS (PW3), noting that both are proposed to be disturbed by a railway for the Olive Downs Project.

Excluding cattle from these wetlands is considered likely to have a positive influence on the condition and ecological value of these wetlands (noting that the aquatic ecological values of these wetlands are limited to times of inundation e.g. during floods, and the wetlands have terrestrial ecological value at other times).

6.3 Erosion and Sediment Control

An Erosion and Sediment Control Plan would be developed and implemented throughout the construction and operation phases of the Project in order to reduce the amount of sediment-laden run-off entering downstream waterways. A ‘best practice’ approach would be adopted that is consistent with the IECA recommendations. The following general principles would apply:

- minimise the surface disturbance areas (which has been incorporated into the design of the Project),
- where possible, apply local temporary erosion control measures,
- intercept run-off from undisturbed areas and divert around surface disturbance areas, through the use of up-catchment diversions, and
- where temporary measures are likely to be ineffective, direct surface water run-off from surface disturbance areas to sediment dams prior to release from the Project area.

Active haul roads would be regularly watered (or applied with dust suppressants) to minimise dust generation potential.

6.4 Management to Prevent and Manage Leaks and Spills

Hazardous chemicals and materials used or stored at the Project would be managed in accordance with Qld and Commonwealth legislation and policy requirements, including their removal from site by authorized contractors as required.

Potential impacts associated with leaks and spills can be managed where appropriate procedures, containment and spill control measures are implemented at suitable locations (e.g. where the transportation and loading, and storage of materials occurs onsite). The design and management of all required fuels and hydrocarbons would ensure that there are effective means of secondary containment to prevent or minimize releases to the environment from any fuel or oil storage onsite. Appropriate storage of chemicals and hydrocarbons would be required during the construction phase of the Project, and as part of ongoing operations.

Provided the appropriate management of chemicals is maintained, the Project is unlikely to result in leaks/spills that would eventuate in serious environmental harm to aquatic species or their habitat.

6.5 Mine Rehabilitation

Rehabilitation activities would be conducted as soon as possible for disused areas. The post-mine landforms would contain a mixture of woodland and pasture and would be rehabilitated in a manner that results in patches of woodland in pasture areas. A Progressive rehabilitation and closure plan would be implemented which outlines suitable rehabilitation schedules, methods and monitoring requirements for areas that can be rehabilitated over the life of the mine as well as final conformance requirements.

6.6 Management Plans

The development and implementation of the following environmental management plans are recommended for the Project:

- Environmental Management Plan – including land clearing measures, management of palustrine wetlands, weed management and animal pest management, and
- Water Management Plan, including erosion and sediment control.

6.7 Monitoring Programs

Implementation of appropriate water quality monitoring programs as appropriate during the construction phase of the Project, as well as designing and implementing a Receiving Environment Monitoring Program (REMP) during the operational phase, would confirm that water quality, and therefore EVs of downstream waterways, are maintained, and can inform adaptive management of mine-affected water discharges if required.

The REMP would be designed in accordance with the *Receiving Environment Monitoring Program Guideline – For use with Environmentally Relevant Activities under the Environment Protection Act 1994* (DES 2014) and include a number of indicators of aquatic ecosystem condition including water quality, sediment quality and macroinvertebrates as biological indicators, as outlined in the *Model Water Conditions for Coal Mines in the Fitzroy Basin* (DES 2013). The macroinvertebrate data collected to date provides a baseline (pre-construction) dataset to be used for the basis of future impact monitoring. Annual REMP reports would be prepared in accordance with the *Model Water Conditions for Coal Mines in the Fitzroy Basin* (DES 2013).

Implementation of appropriate water quality monitoring programs as appropriate, including periodic testing of waste rock and other reject material, as well as implementation of a REMP, would ensure that any issues with water quality associated with seepage are detected and managed appropriately.

6.8 Summary of Impact Avoidance and Mitigation Measures for Matters of National Environmental Significance

As discussed in Section 5.15, no aquatic threatened species or communities would be adversely impacted as a result of the Project, including development of the mine site and access road, water pipeline and ETL. Therefore, no impact avoidance or mitigation measures are required for aquatic threatened species or communities.

All of the measures in Sections 6.1 to 6.7 would avoid and mitigate impacts on water resources (with regard to the “water resources in relation to coal seam gas development and large coal mining development” controlling provision). Some of the proposed measures, such as avoidance and buffering (including exclusion of cattle) of floodplain palustrine wetlands, are likely to enhance the ecological values of these wetlands.

6.9 Summary of Impact Avoidance and Mitigation Measures for Matters of State Environmental Significance

As discussed in Section 5.16, no aquatic MSES would be adversely impacted as a result of the Project. Therefore, no impact avoidance or mitigation measures are required for aquatic MSES.

7 Offsets

The Project (including the mine site and access road, water pipeline and ETL) is not expected to have any significant residual impacts on aquatic MNES, including listed threatened species and ecological communities and water resources in relation to coal seam gas development and large coal mining development. It is also not expected to have any significant residual impacts on aquatic MSES, including listed threatened species, HES wetlands, or fish passage.

Therefore, no offsets are required for aquatic ecology under the *Matters of National Environmental Significance: Significant Impact Guidelines 1.1* (DotE 2013a) and the *Queensland Environmental Offsets Policy – Significant Residual Impact Guideline* (EHP 2014).

8 Conclusion

Aquatic habitats in waterways and wetlands in and downstream of the Project area were typical of ephemeral systems in the broader region, with seasonal patterns in habitat availability and quality. Biological communities (including aquatic plants, macroinvertebrates, macrocrustaceans, fish and turtles) recorded at sites in the Project area and receiving environment were typical of ephemeral systems in central Qld. All taxa recorded were common in the broader region, and no listed threatened species known from the catchment (or potential habitat for these species) were identified.

Emergent growth forms dominated aquatic plant communities, with few submerged and floating species, indicating that water is not likely to persist for the majority of the year (except at wetland and farm dam sites). One introduced aquatic plant species was recorded in the vicinity of the Project: white eclipta (*Eclipta prostrata*); however, this species is considered naturalised across most of Qld.

Macroinvertebrate communities were in low to moderate condition relative to those expected in the broader region, and results indicated that a range of external factors influenced communities at most sites.

Most waterways and wetlands surveyed provided habitat for fish from a range of life-history stages during the wet season, including adults, intermediates and juveniles. One pest species of fish was also recorded in both surveys: mozambique tilapia (*Oreochromis mossambicus*).

Turtles were not particularly abundant or widespread throughout the vicinity of the Project, and were most commonly recorded from farm dams. No potential habitat for the platypus (*Ornithorhynchus anatinus*) was identified.

Overall, aquatic ecosystem values of waterways and wetlands in the Project area and receiving environment were low to moderate, and were considered to be similar to, and representative of, ephemeral systems in the broader region. Mapped lacustrine and palustrine wetlands and farm dams in the Project area and surrounds varied in their aquatic ecosystem value and were assessed as low to moderate.

Several aquatic systems within the vicinity of the Project are mapped in the BOM GDE Atlas: the Isaac River and Cherwell Creek are mapped as having high potential for groundwater interaction; wetlands on the Isaac River floodplain and its tributaries are mapped as having high or moderate potential for groundwater interaction; and farm dams mapped as having high or moderate potential for groundwater interaction. The outcomes of this assessment, in conjunction with the outcomes of the Groundwater and Surface Water and Flooding Assessments for the Project, determined that the aquatic in-stream ecosystems associated with the Isaac River and Cherwell Creek are largely not dependent on the surface-expression of groundwater, but would access groundwater for a short period after rainfall events. The wetlands and farm dams in the locality are not likely to be aquatic GDEs.

No aquatic threatened species or communities listed under NC Act or EPBC Act were captured or considered likely to occur in the Study area. Two aquatic ecology related MSES were recorded in the Study area, namely, a HES wetland and various waterways that provide for fish passage. The HES palustrine wetland, also mapped as a WPA, is present approximately 5 km downstream of the Project area. This wetland was dry during both field surveys, was assessed as having low value for aquatic fauna, and would rarely be inundated (and therefore would rarely provide aquatic habitat). Waterways within the Study area are waterways that provide for fish passage, a MSES; specifically three unnamed tributaries of the Isaac River mapped as low and moderate risk of adverse impacts to fish passage.

No stygofauna specimens were recorded during the surveys, consistent with the results of recent stygofauna sampling conducted for the adjacent Olive Downs Project.

The Project has the potential to directly influence aquatic ecosystems through clearance and modification of aquatic habitat, specifically removal of three unnamed tributaries of the Isaac River, three State-mapped lacustrine wetlands (that have been ground-truthed as farm dams), four other farm dams within the Project area and one palustrine wetland RE identified by E2M (2021). However, no significant impacts to aquatic ecology of the region are expected based on this assessment.

Potential indirect impacts to aquatic ecosystems adjacent to and downstream of the Project area could occur as a result of impacts to water quality and / or flows as a result of the Project. However, where the appropriate mitigation and management strategies, such as implementation of an Erosion and Sediment Control Plan; appropriate management of hazardous chemicals and materials; and implementation of water quality monitoring programs during the construction and operation of the Project, are effectively implemented, the Project is not expected to pose a significant environmental risk on receiving water quality. Furthermore, there is a predicted negligible impact on the water quality or water resources downstream waterways through controlled release of mine-affected water from the Project. Additionally, no measurable impacts to surface water quantity are likely to occur as a result of the excision of catchment area associated with the Project (WRM 2021).

The majority of the overburden and interburden generated from the Project would generally be expected to have a low sulfur content and be NAF. Therefore, the risk of impacts to aquatic ecosystems as a result of acid-mine drainage is expected to be low.

The predicted impacts on the Isaac River alluvium groundwater system would be localised and temporary. No impacts to surface aquatic ecosystems as a result of changes in groundwater are predicted. It is considered unlikely that the Project would result in a significant impact to any stygofauna communities (if they were likely to occur).

Considering the existing impacts in the catchment and provided the appropriate mitigation measures are in place, it is considered unlikely that the Project would result in significant cumulative impact to aquatic ecosystems of the receiving environment of the Isaac River or the Isaac River sub-basin more generally.

Furthermore, implementation of the following management measures would mitigate adverse impacts on aquatic ecology associated with the Project:

- limiting the area of direct impact to aquatic ecosystems to those within the Project area,

- minimising the overall mine footprint by optimising the backfilling of the open cut,
- avoiding clearing of riparian vegetation associated with the Isaac River,
- avoiding creek crossings/waterways for the infrastructure corridor,
- avoiding palustrine wetlands to the north-east of the Project and establishing a 50 m buffer on two of the wetlands (PW1 and PW2),
- ensuring appropriate management plans are developed and implemented for: erosion and sediment control; waste; hydrocarbons and contaminants; and weed and pest animals,
- developing and implementing effective erosion and sediment control strategies that are: designed in accordance with best practice guidelines; designed to contain sediment affected runoff from disturbed areas; and protect against erosion from increased velocities during flood flows (i.e. localised erosion protection works),
- developing and implementing an effective water management system that: minimises the capture of natural flows; effectively manages the storage of mine-affected water as well as clean water; maximises and prioritises use of onsite water retention and recycling; effectively manages acid rock seepage of the mine and achieves WQOs,
- implementing appropriate water quality monitoring programs as appropriate during the construction phase of the Project, as well as designing and implementing a REMP during the operational phase,
- implementing a controlled release strategy that ensures release events would coincide with appropriate streamflow conditions in the Isaac River, and
- designing water storage measures (sediment dams and Mine Water Dams) that ensure uncontrolled release events are highly unlikely.

The Project is not expected to have any significant residual impacts on aquatic threatened species and ecological communities listed under the EPBC Act or have a significant impact on a water-dependant ecosystem. It is also not expected to have any significant residual impacts on aquatic MSES, including threatened species listed under the NC Act, HES wetlands, or fish passage.

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Appendix A Supporting Maps and Species Searches

Australian Government
Department of the Environment and Energy

EPBC Act Protected Matters Report

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

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

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

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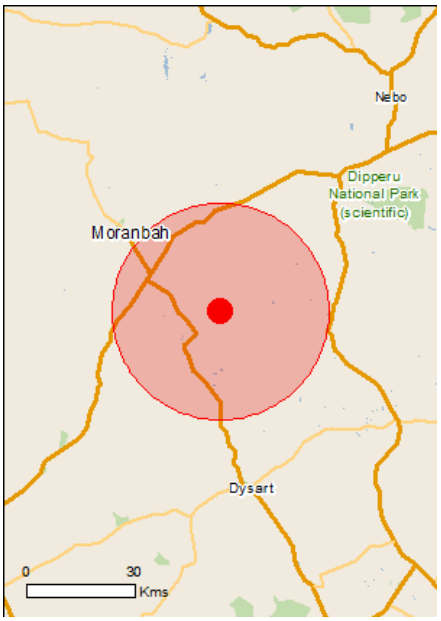

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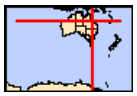

Summary

Matters of National Environmental Significance

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

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Importance:	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	None
Listed Threatened Ecological Communities:	5
Listed Threatened Species:	23
Listed Migratory Species:	12

Other Matters Protected by the EPBC Act

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

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

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

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

Extra Information

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

State and Territory Reserves:	None
Regional Forest Agreements:	None
Invasive Species:	20
Nationally Important Wetlands:	None
Key Ecological Features (Marine)	None

Details

Matters of National Environmental Significance

Listed Threatened Ecological Communities [Resource Information]

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

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

Listed Threatened Species [Resource Information]

Name	Status	Type of Presence
Birds		
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Erythrotriorchis radiatus Red Goshawk [942]	Vulnerable	Species or species habitat likely to occur within area
Geophaps scripta scripta Squatter Pigeon (southern) [64440]	Vulnerable	Species or species habitat known to occur within area
Grantiella picta Painted Honeyeater [470]	Vulnerable	Species or species habitat may occur within area
Neochmia ruficauda ruficauda Star Finch (eastern), Star Finch (southern) [26027]	Endangered	Species or species habitat likely to occur within area
Poephila cincta cincta Southern Black-throated Finch [64447]	Endangered	Species or species habitat may occur within area
Rostratula australis Australian Painted Snipe [77037]	Endangered	Species or species habitat may occur within area
Mammals		
Dasyurus hallucatus Northern Quoll, Digul [Gogo-Yimidir], Wijingadda [Dambimangari], Wiminji [Martu] [331]	Endangered	Species or species habitat likely to occur within area
Macroderma gigas Ghost Bat [174]	Vulnerable	Species or species

Name	Status	Type of Presence
		habitat likely to occur within area
Nyctophilus corbeni Corben's Long-eared Bat, South-eastern Long-eared Bat [83395]	Vulnerable	Species or species habitat may occur within area
Petauroides volans Greater Glider [254]	Vulnerable	Species or species habitat known to occur within area
Phascolarctos cinereus (combined populations of Qld, NSW and the ACT) Koala (combined populations of Queensland, New South Wales and the Australian Capital Territory) [85104]	Vulnerable	Species or species habitat known to occur within area
Plants		
Cycas ophiolitica [55797]	Endangered	Species or species habitat likely to occur within area
Dichanthium queenslandicum King Blue-grass [5481]	Endangered	Species or species habitat likely to occur within area
Dichanthium setosum bluegrass [14159]	Vulnerable	Species or species habitat may occur within area
Eucalyptus raveretiana Black Ironbox [16344]	Vulnerable	Species or species habitat likely to occur within area
Samadera bidwillii Quassia [29708]	Vulnerable	Species or species habitat likely to occur within area
Reptiles		
Denisonia maculata Ornamental Snake [1193]	Vulnerable	Species or species habitat known to occur within area
Egernia rugosa Yakka Skink [1420]	Vulnerable	Species or species habitat may occur within area
Elseya albagula Southern Snapping Turtle, White-throated Snapping Turtle [81648]	Critically Endangered	Species or species habitat likely to occur within area
Furina dunmalli Dunmall's Snake [59254]	Vulnerable	Species or species habitat may occur within area
Lerista allanae Allan's Lerista, Retro Slider [1378]	Endangered	Species or species habitat may occur within area
Rheodytes leukops Fitzroy River Turtle, Fitzroy Tortoise, Fitzroy Turtle, White-eyed River Diver [1761]	Vulnerable	Species or species habitat likely to occur within area

Listed Migratory Species [Resource Information]

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

Name	Threatened	Type of Presence
Migratory Marine Birds		
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Migratory Terrestrial Species		
Cuculus optatus Oriental Cuckoo, Horsfield's Cuckoo [86651]		Species or species

Name	Threatened	Type of Presence
		habitat may occur within area
Monarcha melanopsis Black-faced Monarch [609]		Species or species habitat known to occur within area
Motacilla flava Yellow Wagtail [644]		Species or species habitat may occur within area
Myiagra cyanoleuca Satin Flycatcher [612]		Species or species habitat may occur within area
Migratory Wetlands Species		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat may occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat known to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Gallinago hardwickii Latham's Snipe, Japanese Snipe [863]		Species or species habitat may occur within area
Pandion haliaetus Osprey [952]		Species or species habitat likely to occur within area
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat may occur within area

Other Matters Protected by the EPBC Act

Listed Marine Species [Resource Information]

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

Name	Threatened	Type of Presence
Birds		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat may occur within area
Anseranas semipalmata Magpie Goose [978]		Species or species habitat may occur within area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardea alba Great Egret, White Egret [59541]		Species or species habitat known to occur within area
Ardea ibis Cattle Egret [59542]		Species or species

Name	Threatened	Type of Presence
		habitat may occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat known to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Chrysococcyx osculans Black-eared Cuckoo [705]		Species or species habitat likely to occur within area
Gallinago hardwickii Latham's Snipe, Japanese Snipe [863]		Species or species habitat may occur within area
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat known to occur within area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area
Monarcha melanopsis Black-faced Monarch [609]		Species or species habitat known to occur within area
Motacilla flava Yellow Wagtail [644]		Species or species habitat may occur within area
Myiagra cyanoleuca Satin Flycatcher [612]		Species or species habitat may occur within area
Pandion haliaetus Osprey [952]		Species or species habitat likely to occur within area
Rostratula benghalensis (sensu lato) Painted Snipe [889]	Endangered*	Species or species habitat may occur within area
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat may occur within area

Extra Information

Invasive Species [Resource Information]

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

Name	Status	Type of Presence
Birds		
Lonchura punctulata Nutmeg Mannikin [399]		Species or species habitat likely to occur

Name	Status	Type of Presence within area
Passer domesticus House Sparrow [405]		Species or species habitat likely to occur within area
Streptopelia chinensis Spotted Turtle-Dove [780]		Species or species habitat likely to occur within area
Frogs		
Rhinella marina Cane Toad [83218]		Species or species habitat known to occur within area
Mammals		
Canis lupus familiaris Domestic Dog [82654]		Species or species habitat likely to occur within area
Capra hircus Goat [2]		Species or species habitat likely to occur within area
Felis catus Cat, House Cat, Domestic Cat [19]		Species or species habitat likely to occur within area
Feral deer Feral deer species in Australia [85733]		Species or species habitat likely to occur within area
Mus musculus House Mouse [120]		Species or species habitat likely to occur within area
Oryctolagus cuniculus Rabbit, European Rabbit [128]		Species or species habitat likely to occur within area
Sus scrofa Pig [6]		Species or species habitat likely to occur within area
Vulpes vulpes Red Fox, Fox [18]		Species or species habitat likely to occur within area
Plants		
Acacia nilotica subsp. indica Prickly Acacia [6196]		Species or species habitat may occur within area
Cryptostegia grandiflora Rubber Vine, Rubbervine, India Rubber Vine, India Rubbervine, Palay Rubbervine, Purple Allamanda [18913]		Species or species habitat likely to occur within area
Jatropha gossypifolia Cotton-leaved Physic-Nut, Bellyache Bush, Cotton-leaf Physic Nut, Cotton-leaf Jatropha, Black Physic Nut [7507]		Species or species habitat likely to occur within area
Lantana camara Lantana, Common Lantana, Kamara Lantana, Large-leaf Lantana, Pink Flowered Lantana, Red Flowered Lantana, Red-Flowered Sage, White Sage, Wild Sage [10892]		Species or species habitat likely to occur within area
Opuntia spp. Prickly Pears [82753]		Species or species habitat likely to occur within area
Parkinsonia aculeata Parkinsonia, Jerusalem Thorn, Jelly Bean Tree, Horse Bean [12301]		Species or species habitat likely to occur within area

Name	Status	Type of Presence
Parthenium hysterophorus Parthenium Weed, Bitter Weed, Carrot Grass, False Ragweed [19566]		Species or species habitat likely to occur within area
Vachellia nilotica Prickly Acacia, Blackthorn, Prickly Mimosa, Black Piquant, Babul [84351]		Species or species habitat likely to occur within area

Caveat

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

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

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

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

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

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

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

- migratory and
- marine

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

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

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

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

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

Coordinates

-22.1846 148.2693

Acknowledgements

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

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

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

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

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Queensland Government

Wildlife Online Extract

Search Criteria: Species List for a Specified Point
Species: All
Type: All
Status: All
Records: All
Date: All
Latitude: -22.1846
Longitude: 148.2693
Distance: 30
Email: kkeating@ecosp.com.au
Date submitted: Thursday 09 Jul 2020 12:52:05
Date extracted: Thursday 09 Jul 2020 13:00:02

The number of records retrieved = 864

Kingdom	Class	Family	Scientific Name	Common Name	I	Q	A	Records
animals	amphibians	Bufonidae	*Rhinella marina*	cane toad	Y			17
animals	amphibians	Hylidae	*Litoria inermis*	bumpy rocketfrog		C		5
animals	amphibians	Hylidae	*Litoria rubella*	ruddy treefrog		C		7
animals	amphibians	Hylidae	*Litoria caerulea*	common green treefrog		C		7
animals	amphibians	Hylidae	*Cyclorana brevipes*	superb collared frog		C		4
animals	amphibians	Hylidae	*Cyclorana verrucosa*	rough collared frog		C		2/1
animals	amphibians	Hylidae	*Litoria latopalmata*	broad palmed rocketfrog		C		10
animals	amphibians	Hylidae	*Cyclorana alboguttata*	greenstripe frog		C		5
animals	amphibians	Hylidae	*Cyclorana novaehollandiae*	eastern snapping frog		C		5
animals	amphibians	Hylidae	*Litoria nasuta*	striped rocketfrog		C		1
animals	amphibians	Hylidae	*Litoria rothii*	northern laughing treefrog		C		2
animals	amphibians	Limnodynastidae	*Limnodynastes salmini*	salmon striped frog		C		8
animals	amphibians	Limnodynastidae	*Platyplectrum ornatum*	ornate burrowing frog		C		26
animals	amphibians	Limnodynastidae	*Limnodynastes tasmaniensis*	spotted grassfrog		C		12
animals	amphibians	Limnodynastidae	*Limnodynastes terraereginae*	scarlet sided pobblebonk		C		4
animals	birds	Acanthizidae	*Smicrornis brevirostris*	weebill		C		40
animals	birds	Acanthizidae	*Acanthiza nana*	yellow thornbill		C		10
animals	birds	Acanthizidae	*Gerygone olivacea*	white-throated gerygone		C		28
animals	birds	Acanthizidae	*Acanthiza apicalis*	inland thornbill		C		2
animals	birds	Acanthizidae	*Acanthiza reguloides*	buff-rumped thornbill		C		4
animals	birds	Acanthizidae	*Sericornis frontalis*	white-browed scrubwren		C		1
animals	birds	Acanthizidae	*Acanthiza chrysorrhoa*	yellow-rumped thornbill		C		4
animals	birds	Acanthizidae	*Pyrrholaemus sagittatus*	speckled warbler		C		3
animals	birds	Accipitridae	*Aviceda subcristata*	Pacific baza		C		1
animals	birds	Accipitridae	*Accipiter cirrocephalus*	collared sparrowhawk		C		4
animals	birds	Accipitridae	*Hieraaetus morphnoides*	little eagle		C		1
animals	birds	Accipitridae	*Haliaeetus leucogaster*	white-bellied sea-eagle		C		5
animals	birds	Accipitridae	*Haliastur sphenurus*	whistling kite		C		34
animals	birds	Accipitridae	*Accipiter fasciatus*	brown goshawk		C		3
animals	birds	Accipitridae	*Circus approximans*	swamp harrier		C		1
animals	birds	Accipitridae	*Elanus axillaris*	black-shouldered kite		C		5
animals	birds	Accipitridae	*Circus assimilis*	spotted harrier		C		2
animals	birds	Accipitridae	*Milvus migrans*	black kite		C		11
animals	birds	Accipitridae	*Aquila audax*	wedge-tailed eagle		C		17
animals	birds	Acrocephalidae	*Acrocephalus australis*	Australian reed-warbler		C		9
animals	birds	Aegothelidae	*Aegotheles cristatus*	Australian owlet-nightjar		C		2
animals	birds	Alaudidae	*Mirafra javanica*	Horsfield's bushlark		C		4
animals	birds	Anatidae	*Anas castanea*	chestnut teal		C		2
animals	birds	Anatidae	*Anas superciliosa*	Pacific black duck		C		30
animals	birds	Anatidae	*Chenonetta jubata*	Australian wood duck		C		29
animals	birds	Anatidae	*Dendrocygna eytoni*	plumed whistling-duck		C		12
animals	birds	Anatidae	*Dendrocygna arcuata*	wandering whistling-duck		C		3
animals	birds	Anatidae	*Cygnus atratus*	black swan		C		12
animals	birds	Anatidae	*Anas gracilis*	grey teal		C		26
animals	birds	Anatidae	*Nettapus coromandelianus*	cotton pygmy-goose		C		8
animals	birds	Anatidae	*Aythya australis*	hardhead		C		18

Kingdom	Class	Family	Scientific Name	Common Name	I	Q	A	Records
animals	birds	Anhingidae	*Anhinga novaehollandiae*	Australasian darter		C		19
animals	birds	Ardeidae	*Egretta novaehollandiae*	white-faced heron		C		20
animals	birds	Ardeidae	*Ardea alba modesta*	eastern great egret		C		18
animals	birds	Ardeidae	*Nycticorax caledonicus*	nankeen night-heron		C		4
animals	birds	Ardeidae	*Egretta garzetta*	little egret		C		4
animals	birds	Ardeidae	*Ardea intermedia*	intermediate egret		C		13
animals	birds	Ardeidae	*Ardea pacifica*	white-necked heron		C		12
animals	birds	Ardeidae	*Bubulcus ibis*	cattle egret		C		2
animals	birds	Artamidae	*Cracticus nigrogularis*	pied butcherbird		C		56
animals	birds	Artamidae	*Artamus leucorynchus*	white-breasted woodswallow		C		19
animals	birds	Artamidae	*Cracticus torquatus*	grey butcherbird		C		37
animals	birds	Artamidae	*Strepera graculina*	pied currawong		C		17
animals	birds	Artamidae	*Gymnorhina tibicen*	Australian magpie		C		78
animals	birds	Artamidae	*Artamus cinereus*	black-faced woodswallow		C		10
animals	birds	Artamidae	*Artamus minor*	little woodswallow		C		1
animals	birds	Burhinidae	*Burhinus grallarius*	bush stone-curlew		C		2
animals	birds	Cacatuidae	*Nymphicus hollandicus*	cockatiel		C		6
animals	birds	Cacatuidae	*Eolophus roseicapilla*	galah		C		32
animals	birds	Cacatuidae	*Cacatua galerita*	sulphur-crested cockatoo		C		31
animals	birds	Campephagidae	*Lalage tricolor*	white-winged triller		C		10
animals	birds	Campephagidae	*Coracina maxima*	ground cuckoo-shrike		C		1
animals	birds	Campephagidae	*Coracina novaehollandiae*	black-faced cuckoo-shrike		C		39
animals	birds	Campephagidae	*Coracina papuensis*	white-bellied cuckoo-shrike		C		2
animals	birds	Campephagidae	*Coracina tenuirostris*	cicadabird		C		7
animals	birds	Casuariidae	*Dromaius novaehollandiae*	emu		C		15
animals	birds	Charadriidae	*Vanellus miles*	masked lapwing		C		13
animals	birds	Charadriidae	*Vanellus miles novaehollandiae*	masked lapwing (southern subspecies)		C		8
animals	birds	Charadriidae	*Elseyornis melanops*	black-fronted dotterel		C		12
animals	birds	Ciconiidae	*Ephippiorhynchus asiaticus*	black-necked stork		C		4
animals	birds	Cisticolidae	*Cisticola exilis*	golden-headed cisticola		C		14
animals	birds	Climacteridae	*Climacteris picumnus*	brown treecreeper		C		1
animals	birds	Columbidae	*Phaps chalcoptera*	common bronzewing		C		6
animals	birds	Columbidae	*Geopelia humeralis*	bar-shouldered dove		C		13
animals	birds	Columbidae	*Geophaps scripta scripta*	squatter pigeon (southern subspecies)		V	V	27
animals	birds	Columbidae	*Geopelia cuneata*	diamond dove		C		1
animals	birds	Columbidae	*Geopelia striata*	peaceful dove		C		23
animals	birds	Columbidae	*Ocyphaps lophotes*	crested pigeon		C		23
animals	birds	Coraciidae	*Eurystomus orientalis*	dollarbird		C		27
animals	birds	Corcoracidae	*Corcorax melanorhamphos*	white-winged chough		C		9
animals	birds	Corcoracidae	*Struthidea cinerea*	apostlebird		C		48
animals	birds	Corvidae	*Corvus orru*	Torresian crow		C		98
animals	birds	Corvidae	*Corvus bennetti*	little crow		C		1
animals	birds	Cuculidae	*Centropus phasianinus*	pheasant coucal		C		17
animals	birds	Cuculidae	*Cacomantis flabelliformis*	fan-tailed cuckoo		C		1
animals	birds	Cuculidae	*Scythrops novaehollandiae*	channel-billed cuckoo		C		11
animals	birds	Cuculidae	*Cacomantis variolosus*	brush cuckoo		C		1

Kingdom	Class	Family	Scientific Name	Common Name	I	Q	A	Records
animals	birds	Cuculidae	*Chalcites minutillus*	little bronze-cuckoo		C		2
animals	birds	Cuculidae	*Cacomantis pallidus*	pallid cuckoo		C		8
animals	birds	Cuculidae	*Chalcites lucidus*	shining bronze-cuckoo		C		3
animals	birds	Cuculidae	*Chalcites basalis*	Horsfield's bronze-cuckoo		C		5
animals	birds	Cuculidae	*Eudynamys orientalis*	eastern koel		C		4
animals	birds	Dicruridae	*Dicrurus bracteatus*	spangled drongo		C		4
animals	birds	Estrildidae	*Neochmia temporalis*	red-browed finch		C		1
animals	birds	Estrildidae	*Neochmia modesta*	plum-headed finch		C		2
animals	birds	Estrildidae	*Lonchura castaneothorax*	chestnut-breasted mannikin		C		3
animals	birds	Estrildidae	*Taeniopygia guttata*	zebra finch		C		2
animals	birds	Estrildidae	*Taeniopygia bichenovii*	double-barred finch		C		23
animals	birds	Eurostopodidae	*Eurostopodus mystacalis*	white-throated nightjar		C		2
animals	birds	Falconidae	*Falco berigora*	brown falcon		C		13
animals	birds	Falconidae	*Falco longipennis*	Australian hobby		C		4
animals	birds	Falconidae	*Falco cenchroides*	nankeen kestrel		C		20
animals	birds	Gruidae	*Antigone rubicunda*	brolga		C		21
animals	birds	Halcyonidae	*Dacelo leachii*	blue-winged kookaburra		C		10
animals	birds	Halcyonidae	*Dacelo novaeguineae*	laughing kookaburra		C		37
animals	birds	Halcyonidae	*Todiramphus sanctus*	sacred kingfisher		C		11
animals	birds	Halcyonidae	*Todiramphus macleayii*	forest kingfisher		C		14
animals	birds	Halcyonidae	*Todiramphus pyrrhopygius*	red-backed kingfisher		C		5
animals	birds	Hirundinidae	*Hirundo neoxena*	welcome swallow		C		8
animals	birds	Hirundinidae	*Petrochelidon ariel*	fairy martin		C		10
animals	birds	Hirundinidae	*Petrochelidon nigricans*	tree martin		C		10
animals	birds	Jacanidae	*Irediparra gallinacea*	comb-crested jacana		C		2
animals	birds	Laridae	*Chlidonias hybrida*	whiskered tern		C		1
animals	birds	Laridae	*Chroicocephalus novaehollandiae*	silver gull		C		2
animals	birds	Laridae	*Gelochelidon nilotica*	gull-billed tern		SL		1
animals	birds	Maluridae	*Malurus lamberti*	variegated fairy-wren		C		13
animals	birds	Maluridae	*Malurus cyaneus*	superb fairy-wren		C		1
animals	birds	Maluridae	*Malurus melanocephalus*	red-backed fairy-wren		C		40
animals	birds	Megaluridae	*Megalurus gramineus*	little grassbird		C		1
animals	birds	Megaluridae	*Megalurus timoriensis*	tawny grassbird		C		3
animals	birds	Megaluridae	*Cincloramphus mathewsi*	rufous songlark		C		4
animals	birds	Meliphagidae	*Melithreptus lunatus*	white-naped honeyeater		C		1
animals	birds	Meliphagidae	*Philemon corniculatus*	noisy friarbird		C		42
animals	birds	Meliphagidae	*Manorina melanocephala*	noisy miner		C		24
animals	birds	Meliphagidae	*Acanthagenys rufogularis*	spiny-cheeked honeyeater		C		3
animals	birds	Meliphagidae	*Melithreptus gularis*	black-chinned honeyeater		C		1
animals	birds	Meliphagidae	*Lichmera indistincta*	brown honeyeater		C		15
animals	birds	Meliphagidae	*Gavicalis virescens*	singing honeyeater		C		23
animals	birds	Meliphagidae	*Manorina flavigula*	yellow-throated miner		C		21
animals	birds	Meliphagidae	*Entomyzon cyanotis*	blue-faced honeyeater		C		40
animals	birds	Meliphagidae	*Caligavis chrysops*	yellow-faced honeyeater		C		2
animals	birds	Meliphagidae	*Philemon citreogularis*	little friarbird		C		23
animals	birds	Meliphagidae	*Plectorhyncha lanceolata*	striped honeyeater		C		22

Kingdom	Class	Family	Scientific Name	Common Name	I	Q	A	Records
animals	birds	Meliphagidae	*Melithreptus albogularis*	white-throated honeyeater		C		38
animals	birds	Meliphagidae	*Meliphaga lewinii*	Lewin's honeyeater		C		3
animals	birds	Meliphagidae	*Myzomela obscura*	dusky honeyeater		C		1
animals	birds	Meropidae	*Merops ornatus*	rainbow bee-eater		C		39
animals	birds	Monarchidae	*Monarcha melanopsis*	black-faced monarch		SL		1
animals	birds	Monarchidae	*Grallina cyanoleuca*	magpie-lark		C		53
animals	birds	Monarchidae	*Myiagra rubecula*	leaden flycatcher		C		15
animals	birds	Monarchidae	*Myiagra inquieta*	restless flycatcher		C		4
animals	birds	Motacillidae	*Anthus novaeseelandiae*	Australasian pipit		C		14
animals	birds	Nectariniidae	*Dicaeum hirundinaceum*	mistletoebird		C		10
animals	birds	Neosittidae	*Daphoenositta chrysoptera*	varied sittella		C		8
animals	birds	Oriolidae	*Oriolus sagittatus*	olive-backed oriole		C		10
animals	birds	Oriolidae	*Sphecotheres vieilloti*	Australasian figbird		C		3
animals	birds	Otididae	*Ardeotis australis*	Australian bustard		C		11
animals	birds	Pachycephalidae	*Colluricincla harmonica*	grey shrike-thrush		C		15
animals	birds	Pachycephalidae	*Pachycephala rufiventris*	rufous whistler		C		25
animals	birds	Pachycephalidae	*Colluricincla megarhyncha*	little shrike-thrush		C		1
animals	birds	Pardalotidae	*Pardalotus striatus*	striated pardalote		C		68
animals	birds	Passeridae	*Passer domesticus*	house sparrow	Y			1
animals	birds	Pelecanidae	*Pelecanus conspicillatus*	Australian pelican		C		12
animals	birds	Petroicidae	*Petroica goodenovii*	red-capped robin		C		3
animals	birds	Petroicidae	*Microeca fascinans*	jacky winter		C		6
animals	birds	Phalacrocoracidae	*Phalacrocorax sulcirostris*	little black cormorant		C		17
animals	birds	Phalacrocoracidae	*Microcarbo melanoleucos*	little pied cormorant		C		20
animals	birds	Phalacrocoracidae	*Phalacrocorax carbo*	great cormorant		C		1
animals	birds	Phalacrocoracidae	*Phalacrocorax varius*	pied cormorant		C		4
animals	birds	Phasianidae	*Coturnix ypsilophora*	brown quail		C		10
animals	birds	Phasianidae	*Coturnix pectoralis*	stubble quail		C		2
animals	birds	Podargidae	*Podargus strigoides*	tawny frogmouth		C		12
animals	birds	Podicipedidae	*Podiceps cristatus*	great crested grebe		C		8
animals	birds	Podicipedidae	*Tachybaptus novaehollandiae*	Australasian grebe		C		18
animals	birds	Pomatostomidae	*Pomatostomus temporalis*	grey-crowned babbler		C		30
animals	birds	Psittacidae	*Platycercus adscitus*	pale-headed rosella		C		43
animals	birds	Psittacidae	*Aprosmictus erythropterus*	red-winged parrot		C		20
animals	birds	Psittacidae	*Trichoglossus chlorolepidotus*	scaly-breasted lorikeet		C		2
animals	birds	Psittacidae	*Platycercus adscitus palliceps*	pale-headed rosella (southern form)		C		2
animals	birds	Psittacidae	*Trichoglossus haematodus moluccanus*	rainbow lorikeet		C		36
animals	birds	Ptilonorhynchidae	*Ptilonorhynchus nuchalis*	great bowerbird		C		2
animals	birds	Ptilonorhynchidae	*Ptilonorhynchus maculatus*	spotted bowerbird		C		6
animals	birds	Rallidae	*Porphyrio melanotus*	purple swamphen		C		10
animals	birds	Rallidae	*Gallirallus philippensis*	buff-banded rail		C		1
animals	birds	Rallidae	*Gallinula tenebrosa*	dusky moorhen		C		12
animals	birds	Rallidae	*Porzana fluminea*	Australian spotted crake		C		1
animals	birds	Rallidae	*Fulica atra*	Eurasian coot		C		9
animals	birds	Recurvirostridae	*Himantopus himantopus*	black-winged stilt		C		8
animals	birds	Rhipiduridae	*Rhipidura albiscapa*	grey fantail		C		28

Kingdom	Class	Family	Scientific Name	Common Name	I	Q	A	Records
animals	birds	Rhipiduridae	*Rhipidura rufifrons*	rufous fantail		SL		1
animals	birds	Rhipiduridae	*Rhipidura leucophrys*	willie wagtail		C		38
animals	birds	Scolopacidae	*Tringa stagnatilis*	marsh sandpiper		SL		3
animals	birds	Scolopacidae	*Tringa nebularia*	common greenshank		SL		1
animals	birds	Scolopacidae	*Calidris acuminata*	sharp-tailed sandpiper		SL		1
animals	birds	Strigidae	*Ninox boobook*	southern boobook		C		8
animals	birds	Strigidae	*Ninox connivens*	barking owl		C		2
animals	birds	Threskiornithidae	*Plegadis falcinellus*	glossy ibis		SL		1
animals	birds	Threskiornithidae	*Threskiornis molucca*	Australian white ibis		C		8
animals	birds	Threskiornithidae	*Platalea flavipes*	yellow-billed spoonbill		C		5
animals	birds	Threskiornithidae	*Platalea regia*	royal spoonbill		C		12
animals	birds	Threskiornithidae	*Threskiornis spinicollis*	straw-necked ibis		C		11
animals	birds	Timaliidae	*Zosterops lateralis*	silvereye		C		1
animals	birds	Turnicidae	*Turnix varius*	painted button-quail		C		2
animals	birds	Tytonidae	*Tyto delicatula*	eastern barn owl		C		2
animals	insects	Nymphalidae	*Euploea corinna*	common crow				4
animals	insects	Nymphalidae	*Acraea andromacha andromacha*	glasswing				1
animals	insects	Nymphalidae	*Hypolimnas bolina nerina*	varied eggfly				1
animals	insects	Nymphalidae	*Junonia villida villida*	meadow argus				4
animals	insects	Nymphalidae	*Tirumala hamata hamata*	blue tiger				1
animals	insects	Nymphalidae	*Danaus petilia*	lesser wanderer				1
animals	insects	Papilionidae	*Papilio anactus*	dainty swallowtail				2
animals	insects	Pieridae	*Cepora perimale scyllara*	caper gull (Australian subspecies)				1
animals	insects	Pieridae	*Belenois java teutonia*	caper white				6
animals	insects	Pieridae	*Catopsilia pomona*	lemon migrant				6
animals	insects	Pieridae	*Elodina parthia*	striated pearl-white				1
animals	mammals	Bovidae	*Bos taurus*	European cattle	Y			1
animals	mammals	Canidae	*Canis sp.*		Y			1
animals	mammals	Canidae	*Vulpes vulpes*	red fox	Y			2
animals	mammals	Canidae	*Canis familiaris*	dog	Y			4
animals	mammals	Canidae	*Canis familiaris (dingo)*	dingo				2
animals	mammals	Cervidae	*Axis axis*	chital	Y			3
animals	mammals	Dasyuridae	*Planigale tenuirostris*	narrow-nosed planigale		C		2
animals	mammals	Dasyuridae	*Sminthopsis macroura*	stripe-faced dunnart		C		1
animals	mammals	Emballonuridae	*Saccolaimus flaviventris*	yellow-bellied sheathtail bat		C		12
animals	mammals	Emballonuridae	*Taphozous troughtoni*	Troughton's sheathtail bat		C		4
animals	mammals	Emballonuridae	*Taphozous australis*	coastal sheathtail bat		NT		1
animals	mammals	Felidae	*Felis catus*	cat	Y			2
animals	mammals	Leporidae	*Oryctolagus cuniculus*	rabbit	Y			12
animals	mammals	Macropodidae	*Wallabia bicolor*	swamp wallaby		C		2
animals	mammals	Macropodidae	*Lagorchestes conspicillatus*	spectacled hare-wallaby		C		1
animals	mammals	Macropodidae	*Petrogale inornata*	unadorned rock-wallaby		C		4
animals	mammals	Macropodidae	*Macropus giganteus*	eastern grey kangaroo		C		17
animals	mammals	Macropodidae	*Macropus robustus*	common wallaroo		C		1
animals	mammals	Macropodidae	*Macropus dorsalis*	black-striped wallaby		C		2
animals	mammals	Macropodidae	*Macropus rufus*	red kangaroo		C		1

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animals	mammals	Miniopteridae	*Miniopterus australis*	little bent-wing bat		C		6
animals	mammals	Miniopteridae	*Miniopterus schreibersii oceanensis*	eastern bent-wing bat		C		5
animals	mammals	Molossidae	*Chaerephon jobensis*	northern freetail bat		C		11
animals	mammals	Molossidae	*Tadarida australis*	white-striped freetail bat		C		1
animals	mammals	Molossidae	*Mormopterus ridei*	eastern free-tailed bat		C		6
animals	mammals	Molossidae	*Mormopterus lumsdenae*	northern free-tailed bat		C		9
animals	mammals	Muridae	*Pseudomys gracilicaudatus*	eastern chestnut mouse		C		5
animals	mammals	Muridae	*Hydromys chrysogaster*	water rat		C		5
animals	mammals	Muridae	*Pseudomys delicatulus*	delicate mouse		C		5
animals	mammals	Muridae	*Rattus fuscipes*	bush rat		C		1
animals	mammals	Muridae	*Rattus rattus*	black rat	Y			1
animals	mammals	Muridae	*Mus musculus*	house mouse	Y			8
animals	mammals	Peramelidae	*Isoodon macrourus*	northern brown bandicoot		C		3
animals	mammals	Petauridae	*Petaurus breviceps*	sugar glider		C		6
animals	mammals	Petauridae	*Petaurus norfolcensis*	squirrel glider		C		1
animals	mammals	Petauridae	*Petaurus sp.*					1
animals	mammals	Phalangeridae	*Trichosurus vulpecula*	common brushtail possum		C		8
animals	mammals	Phascolarctidae	*Phascolarctos cinereus*	koala		V	V	97
animals	mammals	Potoroidae	*Aepyprymnus rufescens*	rufous bettong		C		11
animals	mammals	Pseudocheiridae	*Petauroides volans minor*	northern greater glider		V	V	23
animals	mammals	Pseudocheiridae	*Petauroides volans*	greater glider		V	V	54
animals	mammals	Pteropodidae	*Pteropus scapulatus*	little red flying-fox		C		3
animals	mammals	Suidae	*Sus scrofa*	pig	Y			6
animals	mammals	Tachyglossidae	*Tachyglossus aculeatus*	short-beaked echidna		SL		15
animals	mammals	Vespertilionidae	*Chalinolobus nigrogriseus*	hoary wattled bat		C		8
animals	mammals	Vespertilionidae	*Vespadelus baverstocki*	inland forest bat		C		7
animals	mammals	Vespertilionidae	*Vespadelus troughtoni*	eastern cave bat		C		8
animals	mammals	Vespertilionidae	*Scotorepens sanborni*	northern broad-nosed bat		C		2
animals	mammals	Vespertilionidae	*Scotorepens balstoni*	inland broad-nosed bat		C		7
animals	mammals	Vespertilionidae	*Chalinolobus picatus*	little pied bat		C		12
animals	mammals	Vespertilionidae	*Chalinolobus gouldii*	Gould's wattled bat		C		15
animals	mammals	Vespertilionidae	*Chalinolobus dwyeri*	large-eared pied bat		V	V	1
animals	mammals	Vespertilionidae	*Scotorepens greyii*	little broad-nosed bat		C		16
animals	mammals	Vespertilionidae	*Nyctophilus gouldi*	Gould's long-eared bat		C		3
animals	mammals	Vespertilionidae	*Chalinolobus morio*	chocolate wattled bat		C		6
animals	mammals	Vespertilionidae	*Nyctophilus bifax*	northern long-eared bat		C		1
animals	mammals	Vespertilionidae	*Nyctophilus sp.*					3
animals	mammals	Vespertilionidae	*Chalinolobus sp.*					5
animals	ray-finned fishes	Eleotridae	*Oxyeleotris lineolata*	sleepy cod				1
animals	ray-finned fishes	Osteoglossidae	*Scleropages leichardti*	southern saratoga				1
animals	ray-finned fishes	Percichthyidae	*Macquaria ambigua*	golden perch				1
animals	ray-finned fishes	Terapontidae	*Bidyanus bidyanus*	silver perch			CE	1
animals	reptiles	Agamidae	*Pogona barbata*	bearded dragon		C		5
animals	reptiles	Agamidae	*Pogona vitticeps*	central bearded dragon		C		1
animals	reptiles	Agamidae	*Amphibolurus burnsi*	Burns's dragon		C		2
animals	reptiles	Agamidae	*Chlamydosaurus kingii*	frilled lizard		C		1

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animals	reptiles	Agamidae	*Diporiphora australis*	tommy roundhead		C		10/1
animals	reptiles	Boidae	*Aspidites melanocephalus*	black-headed python		C		2
animals	reptiles	Boidae	*Antaresia maculosa*	spotted python		C		8
animals	reptiles	Carphodactylidae	*Nephrurus asper*	spiny knob-tailed gecko		C		3
animals	reptiles	Chelidae	*Emydura sp.*					1
animals	reptiles	Chelidae	*Chelodina longicollis*	eastern snake-necked turtle		C		1
animals	reptiles	Colubridae	*Tropidonophis mairii*	freshwater snake		C		2
animals	reptiles	Colubridae	*Boiga irregularis*	brown tree snake		C		3
animals	reptiles	Diplodactylidae	*Diplodactylus vittatus*	wood gecko		C		1
animals	reptiles	Diplodactylidae	*Amalosia rhombifer*	zig-zag gecko		C		1
animals	reptiles	Diplodactylidae	*Strophurus williamsi*	soft-spined gecko		C		4
animals	reptiles	Diplodactylidae	*Lucasium steindachneri*	Steindachner's gecko		C		13
animals	reptiles	Diplodactylidae	*Diplodactylus platyurus*	eastern fat-tailed gecko		C		10
animals	reptiles	Diplodactylidae	*Oedura monilis sensu lato*	ocellated velvet gecko		C		10
animals	reptiles	Elapidae	*Furina diadema*	red-naped snake		C		1
animals	reptiles	Elapidae	*Denisonia maculata*	ornamental snake		V	V	27
animals	reptiles	Elapidae	*Cryptophis boschmai*	Carpentaria whip snake		C		6
animals	reptiles	Elapidae	*Pseudonaja textilis*	eastern brown snake		C		9
animals	reptiles	Elapidae	*Hoplocephalus bitorquatus*	pale-headed snake		C		6
animals	reptiles	Elapidae	*Suta suta*	myall snake		C		6
animals	reptiles	Elapidae	*Acanthophis antarcticus*	common death adder		V		1
animals	reptiles	Elapidae	*Demansia psammophis*	yellow-faced whipsnake		C		3
animals	reptiles	Gekkonidae	*Heteronotia binoei*	Bynoe's gecko		C		30
animals	reptiles	Gekkonidae	*Gehyra versicolor*			C		1
animals	reptiles	Gekkonidae	*Gehyra dubia*	dubious dtella		C		28/1
animals	reptiles	Gekkonidae	*Gehyra catenata*	chain-backed dtella		C		8
animals	reptiles	Pygopodidae	*Paradelma orientalis*	brigalow scaly-foot		C		1
animals	reptiles	Pygopodidae	*Lialis burtonis*	Burton's legless lizard		C		2
animals	reptiles	Pygopodidae	*Pygopus schraderi*	eastern hooded scaly-foot		C		1
animals	reptiles	Scincidae	*Carlia munda*	shaded-litter rainbow-skink		C		3
animals	reptiles	Scincidae	*Carlia vivax*	tussock rainbow-skink		C		3
animals	reptiles	Scincidae	*Carlia rubigo*	orange-flanked rainbow skink		C		10
animals	reptiles	Scincidae	*Cryptoblepharus virgatus sensu lato*			C		7
animals	reptiles	Scincidae	*Cryptoblepharus pulcher pulcher*	elegant snake-eyed skink		C		6
animals	reptiles	Scincidae	*Carlia pectoralis sensu lato*			C		19
animals	reptiles	Scincidae	*Glaphyromorphus punctulatus*	fine-spotted mulch-skink		C		1/1
animals	reptiles	Scincidae	*Cryptoblepharus pannosus*	ragged snake-eyed skink		C		2
animals	reptiles	Scincidae	*Lerista punctatovittata*	eastern robust slider		C		1
animals	reptiles	Scincidae	*Pygmaeascincus timlowi*	dwarf litter-skink		C		2
animals	reptiles	Scincidae	*Morethia taeniopleura*	fire-tailed skink		C		4
animals	reptiles	Scincidae	*Ctenotus taeniolatus*	copper-tailed skink		C		15
animals	reptiles	Scincidae	*Morethia boulengeri*	south-eastern morethia skink		C		7
animals	reptiles	Scincidae	*Lygisaurus foliorum*	tree-base litter-skink		C		10
animals	reptiles	Scincidae	*Cryptoblepharus sp.*					1
animals	reptiles	Scincidae	*Tiliqua scincoides*	eastern blue-tongued lizard		C		2
animals	reptiles	Scincidae	*Ctenotus spaldingi*	straight-browed ctenotus		C		15

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animals	reptiles	Scincidae	*Bellatorias frerei*	major skink		C		1
animals	reptiles	Scincidae	*Carlia schmeltzii*	robust rainbow-skink		C		6/1
animals	reptiles	Scincidae	*Lerista fragilis*	eastern mulch slider		C		13/1
animals	reptiles	Scincidae	*Ctenotus ingrami*	unspotted yellow-sided ctenotus		C		1
animals	reptiles	Scincidae	*Tiliqua rugosa*	shingle-back		C		1
animals	reptiles	Scincidae	*Menetia greyii*	common dwarf skink		C		2
animals	reptiles	Scincidae	*Eulamprus sp.*					2
animals	reptiles	Typhlopidae	*Anilios unguirostris*	claw-snouted blind snake		C		1
animals	reptiles	Typhlopidae	*Anilios affinis*	small-headed blind snake		C		1
animals	reptiles	Varanidae	*Varanus tristis*	black-tailed monitor		C		5
fungi	lecanoromycetes	Cladoniaceae	*Cladia muelleri*			C		1/1
fungi	lecanoromycetes	Cladoniaceae	*Ramalinora glaucolivida*			C		1/1
fungi	lecanoromycetes	Lecideaceae	*Lecidea*					3/3
fungi	lecanoromycetes	Parmeliaceae	*Xanthoparmelia ballingalliana*			C		2/2
fungi	lecanoromycetes	Parmeliaceae	*Xanthoparmelia exuviata*			C		1/1
fungi	lecanoromycetes	Physciaceae	*Rinodina*					1/1
fungi	lecanoromycetes	Porinaceae	*Porina subargillacea*			C		1/1
fungi	lecanoromycetes	Teloschistaceae	*Caloplaca cinnabarina*			C		1/1
fungi	lichinomycetes	Peltulaceae	*Peltula placodizans*			C		1/1
plants	land plants	Acanthaceae	*Pseuderanthemum variabile*	pastel flower		C		2/1
plants	land plants	Acanthaceae	*Brunoniella australis*	blue trumpet		C		13
plants	land plants	Acanthaceae	*Rostellularia adscendens*			C		26/1
plants	land plants	Acanthaceae	*Rostellularia adscendens var. hispida*			C		1/1
plants	land plants	Aizoaceae	*Trianthema triquetra*	red spinach		C		1
plants	land plants	Aizoaceae	*Trianthema portulacastrum*	black pigweed	Y			3
plants	land plants	Amaranthaceae	*Gomphrena celosioides*	gomphrena weed	Y			5
plants	land plants	Amaranthaceae	*Alternanthera denticulata var. micrantha*			C		6
plants	land plants	Amaranthaceae	*Alternanthera denticulata*	lesser joyweed		C		1
plants	land plants	Amaranthaceae	*Ptilotus*					1
plants	land plants	Amaranthaceae	*Alternanthera nana*	hairy joyweed		C		2/2
plants	land plants	Amaranthaceae	*Alternanthera nodiflora*	joyweed		C		1
plants	land plants	Amaryllidaceae	*Crinum*					1
plants	land plants	Apiaceae	*Eryngium plantagineum*	long eryngium		C		2/2
plants	land plants	Apocynaceae	*Marsdenia*					1
plants	land plants	Apocynaceae	*Carissa ovata*	currantbush		C		11
plants	land plants	Apocynaceae	*Wrightia saligna*			C		1/1
plants	land plants	Apocynaceae	*Parsonsia eucalyptophylla*	gargaloo		C		1
plants	land plants	Apocynaceae	*Alstonia constricta*	bitterbark		C		2
plants	land plants	Apocynaceae	*Alyxia ruscifolia*			C		1/1
plants	land plants	Apocynaceae	*Marsdenia viridiflora*			C		1
plants	land plants	Apocynaceae	*Hoya australis subsp. australis*			C		1/1
plants	land plants	Apocynaceae	*Marsdenia australis*	doubah		C		1
plants	land plants	Apocynaceae	*Wrightia versicolor*			C		1/1
plants	land plants	Apocynaceae	*Parsonsia lanceolata*	northern silkpod		C		3/2
plants	land plants	Araliaceae	*Polyscias elegans*	celery wood		C		1/1
plants	land plants	Asphodelaceae	*Bulbine bulbosa*	golden lily		C		2

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plants	land plants	Asteraceae	*Gamochaeta pensylvanica*		Y			1/1
plants	land plants	Asteraceae	*Acanthospermum hispidum*	star burr	Y			1
plants	land plants	Asteraceae	*Euchiton involucratus*			C		3
plants	land plants	Asteraceae	*Cyanthillium cinereum*			C		2/1
plants	land plants	Asteraceae	*Vittadinia pustulata*			C		1/1
plants	land plants	Asteraceae	*Pterocaulon redolens*			C		6
plants	land plants	Asteraceae	*Peripleura hispidula*			C		2
plants	land plants	Asteraceae	*Rutidosis leucantha*			C		1/1
plants	land plants	Asteraceae	*Praxelis clematidea*		Y			1/1
plants	land plants	Asteraceae	*Coronidium rupicola*			C		1/1
plants	land plants	Asteraceae	*Emilia sonchifolia*		Y			2
plants	land plants	Asteraceae	*Calotis cuneifolia*	burr daisy		C		1
plants	land plants	Asteraceae	*Tridax procumbens*	tridax daisy	Y			1/1
plants	land plants	Asteraceae	*Sonchus oleraceus*	common sowthistle	Y			1
plants	land plants	Asteraceae	*Blumea axillaris*			C		2/2
plants	land plants	Asteraceae	*Calotis dentex*	white burr daisy		C		1/1
plants	land plants	Asteraceae	*Bidens pilosa*		Y			2
plants	land plants	Asteraceae	*Senecio pinnatifolius var. pinnatifolius*			C		2
plants	land plants	Asteraceae	*Apowollastonia spilanthoides*			C		10/3
plants	land plants	Asteraceae	*Sphaeromorphaea subintegra*			C		1/1
plants	land plants	Asteraceae	*Sphaeromorphaea australis*			C		1/1
plants	land plants	Asteraceae	*Pterocaulon sphacelatum*	applebush		C		2
plants	land plants	Asteraceae	*Parthenium hysterophorus*	parthenium weed	Y			42
plants	land plants	Boraginaceae	*Ehretia membranifolia*	weeping koda		C		2
plants	land plants	Boraginaceae	*Trichodesma zeylanicum*			C		5
plants	land plants	Brassicaceae	*Cardamine hirsuta*	common bittercress	Y			1/1
plants	land plants	Byttneriaceae	*Hannafordia shanesii*			C		1/1
plants	land plants	Cactaceae	*Opuntia*					1
plants	land plants	Cactaceae	*Opuntia stricta*		Y			1
plants	land plants	Cactaceae	*Harrisia martinii*		Y			10
plants	land plants	Cactaceae	*Opuntia tomentosa*	velvety tree pear	Y			7
plants	land plants	Caesalpiniaceae	*Lysiphyllum carronii*	ebony tree		C		4
plants	land plants	Caesalpiniaceae	*Chamaecrista absus var. absus*			C		1/1
plants	land plants	Caesalpiniaceae	*Senna artemisioides subsp. zygophylla*			C		1
plants	land plants	Caesalpiniaceae	*Senna coronilloides*			C		1/1
plants	land plants	Caesalpiniaceae	*Senna barclayana*			C		1
plants	land plants	Caesalpiniaceae	*Cassia brewsteri*			C		15
plants	land plants	Caesalpiniaceae	*Senna*					2
plants	land plants	Caesalpiniaceae	*Lysiphyllum*					2
plants	land plants	Campanulaceae	*Wahlenbergia queenslandica*			C		1/1
plants	land plants	Campanulaceae	*Wahlenbergia gracilis*	sprawling bluebell		C		6
plants	land plants	Capparaceae	*Capparis mitchellii*			C		1
plants	land plants	Capparaceae	*Capparis lasiantha*	nipan		C		11
plants	land plants	Capparaceae	*Capparis*					2
plants	land plants	Capparaceae	*Capparis anomala*			C		5
plants	land plants	Capparaceae	*Capparis umbonata*			C		1/1

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plants	land plants	Capparaceae	*Capparis canescens*			C		1
plants	land plants	Capparaceae	*Capparis shanesiana*			C		1/1
plants	land plants	Capparaceae	*Capparis loranthifolia*			C		1
plants	land plants	Capparaceae	*Capparis humistrata*			E		1/1
plants	land plants	Caryophyllaceae	*Polycarpaea longiflora*			C		5
plants	land plants	Casuarinaceae	*Casuarina cristata*	belah		C		1
plants	land plants	Casuarinaceae	*Allocasuarina luehmannii*	bull oak		C		2
plants	land plants	Casuarinaceae	*Casuarina cunninghamiana*			C		1
plants	land plants	Casuarinaceae	*Casuarina cunninghamiana subsp. cunninghamiana*			C		3
plants	land plants	Celastraceae	*Denhamia bilocularis*			C		1
plants	land plants	Celastraceae	*Denhamia cunninghamii*			C		2/1
plants	land plants	Celastraceae	*Elaeodendron australe*			C		1
plants	land plants	Celastraceae	*Denhamia disperma*			C		3
plants	land plants	Chenopodiaceae	*Enchylaena tomentosa var. tomentosa*			C		3
plants	land plants	Chenopodiaceae	*Dysphania melanocarpa forma melanocarpa*			C		1/1
plants	land plants	Chenopodiaceae	*Salsola australis*			C		2
plants	land plants	Chenopodiaceae	*Enchylaena tomentosa*			C		10
plants	land plants	Chenopodiaceae	*Maireana microphylla*			C		2
plants	land plants	Chenopodiaceae	*Sclerolaena lanicuspis*			C		1/1
plants	land plants	Chenopodiaceae	*Sclerolaena tetracuspis*	brigalow burr		C		1/1
plants	land plants	Chenopodiaceae	*Sclerolaena muricata var. villosa*			C		3
plants	land plants	Chenopodiaceae	*Sclerolaena muricata var. muricata*			C		3/1
plants	land plants	Cleomaceae	*Cleome viscosa*	tick-weed		C		6
plants	land plants	Clusiaceae	*Hypericum gramineum*			C		2/2
plants	land plants	Combretaceae	*Terminalia oblongata subsp. oblongata*			C		1
plants	land plants	Commelinaceae	*Commelina*					1
plants	land plants	Commelinaceae	*Commelina diffusa*	wandering jew		C		5
plants	land plants	Convolvulaceae	*Polymeria longifolia*	polymeria		C		17
plants	land plants	Convolvulaceae	*Xenostegia tridentata*			C		1/1
plants	land plants	Convolvulaceae	*Jacquemontia paniculata*			C		3/1
plants	land plants	Convolvulaceae	*Evolvulus alsinoides var. decumbens*			C		1
plants	land plants	Convolvulaceae	*Ipomoea lonchophylla*			C		30
plants	land plants	Convolvulaceae	*Evolvulus alsinoides*			C		5
plants	land plants	Convolvulaceae	*Polymeria pusilla*			C		7
plants	land plants	Convolvulaceae	*Ipomoea plebeia*	bellvine		C		1
plants	land plants	Convolvulaceae	*Ipomoea brownii*			C		1/1
plants	land plants	Convolvulaceae	*Ipomoea calobra*			C		1/1
plants	land plants	Cucurbitaceae	*Cucurbitaceae*					1
plants	land plants	Cucurbitaceae	*Cucumis melo*			C		5
plants	land plants	Cyperaceae	*Cyperus gilesii*			C		24
plants	land plants	Cyperaceae	*Scleria brownii*			C		1/1
plants	land plants	Cyperaceae	*Cyperus gracilis*			C		1/1
plants	land plants	Cyperaceae	*Cyperus concinnus*			C		2
plants	land plants	Cyperaceae	*Cyperus exaltatus*	tall flatsedge		C		7
plants	land plants	Cyperaceae	*Cyperus flaccidus*			C		1/1
plants	land plants	Cyperaceae	*Cyperus javanicus*			C		1/1

Kingdom	Class	Family	Scientific Name	Common Name	I	Q	A	Records
plants	land plants	Cyperaceae	*Cyperus compressus*		Y			1/1
plants	land plants	Cyperaceae	*Cyperus pulchellus*			C		1/1
plants	land plants	Cyperaceae	*Scleria sphacelata*			C		1
plants	land plants	Cyperaceae	*Cyperus isabellinus*			C		1/1
plants	land plants	Cyperaceae	*Cyperus alopecuroides*			C		1/1
plants	land plants	Cyperaceae	*Cyperus alterniflorus*			C		1/1
plants	land plants	Cyperaceae	*Fimbristylis depauperata*			C		1/1
plants	land plants	Cyperaceae	*Cyperus conicus var. conicus*			C		1/1
plants	land plants	Cyperaceae	*Schoenoplectiella dissachantha*			C		3
plants	land plants	Cyperaceae	*Cyperus polystachyos var. polystachyos*			C		1/1
plants	land plants	Cyperaceae	*Gahnia aspera*			C		1
plants	land plants	Cyperaceae	*Cyperus iria*			C		1/1
plants	land plants	Cyperaceae	*Scleria rugosa*			C		1/1
plants	land plants	Cyperaceae	*Cyperus betchei*			C		2
plants	land plants	Cyperaceae	*Cyperus distans*			C		3
plants	land plants	Droseraceae	*Drosera*					1
plants	land plants	Ebenaceae	*Diospyros humilis*	small-leaved ebony		C		4/1
plants	land plants	Erythroxylaceae	*Erythroxylum australe*	cocaine tree		C		7
plants	land plants	Euphorbiaceae	*Bertya pedicellata*			NT		9/8
plants	land plants	Euphorbiaceae	*Croton phebalioides*	narrow-leaved croton		C		1
plants	land plants	Euphorbiaceae	*Euphorbia coghlanii*			C		6
plants	land plants	Euphorbiaceae	*Alchornea ilicifolia*	native holly		C		1
plants	land plants	Euphorbiaceae	*Euphorbia drummondii*			C		8
plants	land plants	Euphorbiaceae	*Mallotus philippensis*	red kamala		C		1
plants	land plants	Euphorbiaceae	*Adriana tomentosa var. tomentosa*			C		1/1
plants	land plants	Euphorbiaceae	*Euphorbia tannensis subsp. eremophila*			C		1
plants	land plants	Euphorbiaceae	*Ricinus communis*	castor oil bush	Y			1
plants	land plants	Euphorbiaceae	*Euphorbia*					1/1
plants	land plants	Euphorbiaceae	*Euphorbia hirta*		Y			1
plants	land plants	Euphorbiaceae	*Croton insularis*	Queensland cascarilla		C		1/1
plants	land plants	Fabaceae	*Zornia muelleriana subsp. muelleriana*			C		1/1
plants	land plants	Fabaceae	*Macroptilium lathyroides var. semierectum*		Y			1
plants	land plants	Fabaceae	*Tephrosia filipes var. (Mt Blackjack A.R.Bean+ 7332)*			C		1/1
plants	land plants	Fabaceae	*Vigna radiata var. sublobata*			C		5
plants	land plants	Fabaceae	*Rhynchosia minima var. minima*			C		18
plants	land plants	Fabaceae	*Galactia tenuiflora var. lucida*			C		1/1
plants	land plants	Fabaceae	*Tephrosia filipes subsp. filipes*			C		1/1
plants	land plants	Fabaceae	*Sesbania cannabina var. cannabina*			C		2
plants	land plants	Fabaceae	*Zornia muriculata subsp. angustata*			C		1/1
plants	land plants	Fabaceae	*Zornia*					1
plants	land plants	Fabaceae	*Desmodium*					1
plants	land plants	Fabaceae	*Tephrosia*					2/2
plants	land plants	Fabaceae	*Crotalaria*					1
plants	land plants	Fabaceae	*Indigofera*					1
plants	land plants	Fabaceae	*Cullen tenax*	emu-foot		C		9

Kingdom	Class	Family	Scientific Name	Common Name	I	Q	A	Records
plants	land plants	Fabaceae	*Glycine falcata*			C		14
plants	land plants	Fabaceae	*Zornia areolata*			C		1/1
plants	land plants	Fabaceae	*Glycine tabacina*	glycine pea		C		2
plants	land plants	Fabaceae	*Lablab purpureus*	lablab	Y			1/1
plants	land plants	Fabaceae	*Vigna lanceolata*			C		29
plants	land plants	Fabaceae	*Crotalaria juncea*	sunhemp	Y			17/1
plants	land plants	Fabaceae	*Galactia muelleri*			C		7
plants	land plants	Fabaceae	*Glycine latifolia*			C		2
plants	land plants	Fabaceae	*Rhynchosia minima*			C		11
plants	land plants	Fabaceae	*Tephrosia filipes*			C		3
plants	land plants	Fabaceae	*Crotalaria montana*			C		4
plants	land plants	Fabaceae	*Glycine tomentella*	woolly glycine		C		1/1
plants	land plants	Fabaceae	*Indigofera hirsuta*	hairy indigo		C		1/1
plants	land plants	Fabaceae	*Sesbania cannabina*			C		8
plants	land plants	Fabaceae	*Zornia muelleriana*			C		1
plants	land plants	Fabaceae	*Aeschynomene indica*	budda pea		C		2
plants	land plants	Fabaceae	*Desmodium filiforme*			C		1/1
plants	land plants	Fabaceae	*Desmodium tortuosum*	Florida beggar-weed	Y			1/1
plants	land plants	Fabaceae	*Galactia tenuiflora*			C		2
plants	land plants	Fabaceae	*Stylosanthes hamata*		Y			13/1
plants	land plants	Fabaceae	*Stylosanthes scabra*		Y			4
plants	land plants	Fabaceae	*Indigofera linifolia*			C		11
plants	land plants	Fabaceae	*Pycnospora lutescens*	pycnospora		C		1/1
plants	land plants	Fabaceae	*Desmodium brachypodum*	large ticktrefoil		C		1/1
plants	land plants	Fabaceae	*Desmodium macrocarpum*			C		5/4
plants	land plants	Fabaceae	*Desmodium campylocaulon*			C		8
plants	land plants	Fabaceae	*Macroptilium atropurpureum*	siratro	Y			5
plants	land plants	Frullaniaceae	*Frullania*					1/1
plants	land plants	Goodeniaceae	*Goodenia*					1
plants	land plants	Goodeniaceae	*Goodenia glabra*			C		18
plants	land plants	Goodeniaceae	*Goodenia sp. (Mt Castletower M.D.Crisp 2753)*			C		2/2
plants	land plants	Goodeniaceae	*Goodenia rotundifolia*			C		1
plants	land plants	Goodeniaceae	*Goodenia grandiflora*			C		2/2
plants	land plants	Haloragaceae	*Haloragis stricta*			C		13
plants	land plants	Hemerocallidaceae	*Dianella nervosa*			C		1
plants	land plants	Hemerocallidaceae	*Dianella longifolia*			C		3
plants	land plants	Hemerocallidaceae	*Dianella*					1
plants	land plants	Juncaceae	*Juncus bufonius*	toad rush	Y			1/1
plants	land plants	Lamiaceae	*Mentha*					1
plants	land plants	Lamiaceae	*Plectranthus*					1
plants	land plants	Lamiaceae	*Clerodendrum floribundum*			C		2
plants	land plants	Lamiaceae	*Teucrium integrifolium*			C		1/1
plants	land plants	Lamiaceae	*Basilicum polystachyon*			C		5
plants	land plants	Lamiaceae	*Leucas lavandulifolia*		Y			1/1
plants	land plants	Lamiaceae	*Prostanthera collina*			C		1/1
plants	land plants	Lamiaceae	*Ocimum tenuiflorum*			C		3

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plants	land plants	Lamiaceae	*Teucrium junceum*			C		1/1
plants	land plants	Lamiaceae	*Coleus diversus*			C		1/1
plants	land plants	Lauraceae	*Cassytha pubescens*	downy devil's twine		C		1
plants	land plants	Laxmanniaceae	*Lomandra multiflora*			C		3
plants	land plants	Laxmanniaceae	*Lomandra longifolia*			C		2/2
plants	land plants	Laxmanniaceae	*Laxmannia gracilis*	slender wire lily		C		1
plants	land plants	Laxmanniaceae	*Eustrephus latifolius*	wombat berry		C		3/1
plants	land plants	Linderniaceae	*Torenia crustacea*			C		1/1
plants	land plants	Loganiaceae	*Mitrasacme micrantha*			C		1/1
plants	land plants	Loganiaceae	*Mitrasacme*					1/1
plants	land plants	Malvaceae	*Sida sp. (Charters Towers E.J.THompson+ CHA456)*			C		2/2
plants	land plants	Malvaceae	*Hibiscus sturtii*			C		3/2
plants	land plants	Malvaceae	*Hibiscus sp. (Emerald S.L.Everist 2124)*			C		1/1
plants	land plants	Malvaceae	*Malvastrum americanum var. stellatum*			C		1/1
plants	land plants	Malvaceae	*Sida rohlenae subsp. rohlenae*			C		1
plants	land plants	Malvaceae	*Hibiscus sturtii var. sturtii*			C		1/1
plants	land plants	Malvaceae	*Hibiscus krichauffianus*			C		1/1
plants	land plants	Malvaceae	*Hibiscus heterophyllus*			C		1/1
plants	land plants	Malvaceae	*Malvastrum americanum*		Y			28
plants	land plants	Malvaceae	*Abutilon micropetalum*			C		1/1
plants	land plants	Malvaceae	*Abutilon leucopetalum*			C		6
plants	land plants	Malvaceae	*Abelmoschus ficulneus*	native rosella		C		12/1
plants	land plants	Malvaceae	*Hibiscus verdcourtii*			C		1/1
plants	land plants	Malvaceae	*Hibiscus meraukensis*	Merauke hibiscus		C		1
plants	land plants	Malvaceae	*Hibiscus divaricatus*			C		2/2
plants	land plants	Malvaceae	*Hibiscus splendens*	pink hibiscus		C		2/2
plants	land plants	Malvaceae	*Gossypium australe*			C		1/1
plants	land plants	Malvaceae	*Sida cunninghamii*			C		2
plants	land plants	Malvaceae	*Sida hackettiana*			C		4
plants	land plants	Malvaceae	*Sida everistiana*			C		1
plants	land plants	Malvaceae	*Sida atherophora*			C		1/1
plants	land plants	Malvaceae	*Sida*					14/2
plants	land plants	Malvaceae	*Sida spinosa*	spiny sida	Y			26/2
plants	land plants	Malvaceae	*Sida corrugata*			C		22
plants	land plants	Malvaceae	*Abutilon hannii*			C		2
plants	land plants	Malvaceae	*Sida cordifolia*		Y			4
plants	land plants	Malvaceae	*Sida fibulifera*			C		1/1
plants	land plants	Malvaceae	*Sida trichopoda*			C		16/2
plants	land plants	Malvaceae	*Abutilon fraseri*	dwarf lantern flower		C		1
plants	land plants	Malvaceae	*Sida sp. (Musselbrook M.B.Thomas+ MRS437)*			C		2
plants	land plants	Marsileaceae	*Marsilea mutica*	shiny nardoo		C		3
plants	land plants	Marsileaceae	*Marsilea drummondii*	common nardoo		C		1
plants	land plants	Meliaceae	*Owenia acidula*	emu apple		C		6
plants	land plants	Meliaceae	*Owenia x reliqua*			C		1/1
plants	land plants	Menispermaceae	*Tinospora smilacina*	snakevine		C		1
plants	land plants	Mimosaceae	*Acacia rhodoxylon*	ringy rosewood		C		18

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plants	land plants	Mimosaceae	*Acacia flavescens*	toothed wattle		C		4
plants	land plants	Mimosaceae	*Acacia catenulata*	bendee		C		1
plants	land plants	Mimosaceae	*Acacia leiocalyx*			C		1
plants	land plants	Mimosaceae	*Acacia fodinalis*			C		1/1
plants	land plants	Mimosaceae	*Acacia shirleyi*	lancewood		C		44/1
plants	land plants	Mimosaceae	*Acacia salicina*	doolan		C		3
plants	land plants	Mimosaceae	*Acacia oswaldii*	miljee		C		2/1
plants	land plants	Mimosaceae	*Acacia cowleana*			C		1/1
plants	land plants	Mimosaceae	*Acacia conferta*			C		1/1
plants	land plants	Mimosaceae	*Acacia faucium*			C		1/1
plants	land plants	Mimosaceae	*Acacia excelsa*			C		3
plants	land plants	Mimosaceae	*Acacia crassa*			C		1
plants	land plants	Mimosaceae	*Acacia*					3
plants	land plants	Mimosaceae	*Albizia canescens*			C		2/1
plants	land plants	Mimosaceae	*Acacia harpophylla*	brigalow		C		8
plants	land plants	Mimosaceae	*Acacia bancroftiorum*			C		2/2
plants	land plants	Mimosaceae	*Vachellia farnesiana*		Y			23
plants	land plants	Mimosaceae	*Acacia julifera subsp. curvinervia*			C		4/4
plants	land plants	Mimosaceae	*Acacia leiocalyx subsp. leiocalyx*			C		1
plants	land plants	Mimosaceae	*Archidendropsis basaltica*	red lancewood		C		3
plants	land plants	Mimosaceae	*Neptunia gracilis forma gracilis*			C		25/1
plants	land plants	Molluginaceae	*Glinus lotoides*	hairy carpet weed		C		1/1
plants	land plants	Moraceae	*Ficus opposita*			C		3
plants	land plants	Myrsinaceae	*Myrsine variabilis*			C		1/1
plants	land plants	Myrtaceae	*Eucalyptus apothalassica*			C		4
plants	land plants	Myrtaceae	*Eucalyptus drepanophylla*			C		1/1
plants	land plants	Myrtaceae	*Lysicarpus angustifolius*	budgeroo		C		2/2
plants	land plants	Myrtaceae	*Corymbia citriodora subsp. citriodora*			C		34
plants	land plants	Myrtaceae	*Eucalyptus camaldulensis subsp. acuta*			C		2
plants	land plants	Myrtaceae	*Corymbia trachyphloia subsp. trachyphloia*			C		1/1
plants	land plants	Myrtaceae	*Corymbia*					3
plants	land plants	Myrtaceae	*Melaleuca*					1
plants	land plants	Myrtaceae	*Myrtaceae*					2
plants	land plants	Myrtaceae	*Eucalyptus*					3
plants	land plants	Myrtaceae	*Corymbia aureola*			C		9/9
plants	land plants	Myrtaceae	*Gossia bidwillii*			C		1/1
plants	land plants	Myrtaceae	*Eucalyptus crebra*	narrow-leaved red ironbark		C		8/1
plants	land plants	Myrtaceae	*Melaleuca nervosa*			C		2/1
plants	land plants	Myrtaceae	*Eucalyptus exserta*	Queensland peppermint		C		1/1
plants	land plants	Myrtaceae	*Eucalyptus coolabah*	coolabah		C		1
plants	land plants	Myrtaceae	*Eucalyptus populnea*	poplar box		C		10
plants	land plants	Myrtaceae	*Corymbia dallachiana*			C		4
plants	land plants	Myrtaceae	*Corymbia tessellaris*	Moreton Bay ash		C		5
plants	land plants	Myrtaceae	*Corymbia clarksoniana*			C		4/2
plants	land plants	Myrtaceae	*Eucalyptus cambageana*	Dawson gum		C		2
plants	land plants	Myrtaceae	*Eucalyptus persistens*			C		1/1

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plants	land plants	Myrtaceae	*Eucalyptus thozetiana*			C		2/2
plants	land plants	Myrtaceae	*Melaleuca fluviatilis*			C		1/1
plants	land plants	Myrtaceae	*Melaleuca leucadendra*	broad-leaved tea-tree		C		2
plants	land plants	Myrtaceae	*Melaleuca viridiflora*			C		2
plants	land plants	Myrtaceae	*Corymbia erythrophloia*	variable-barked bloodwood		C		4
plants	land plants	Myrtaceae	*Eucalyptus orgadophila*	mountain coolibah		C		1
plants	land plants	Myrtaceae	*Eucalyptus tholiformis*			C		2/2
plants	land plants	Myrtaceae	*Micromyrtus capricornia*			C		1/1
plants	land plants	Nyctaginaceae	*Boerhavia burbidgeana*			C		1
plants	land plants	Nyctaginaceae	*Boerhavia dominii*			C		2
plants	land plants	Oleaceae	*Jasminum didymum subsp. lineare*			C		1
plants	land plants	Oleaceae	*Jasminum simplicifolium subsp. australiense*			C		1/1
plants	land plants	Onagraceae	*Ludwigia octovalvis*	willow primrose		C		3
plants	land plants	Orchidaceae	*Cymbidium canaliculatum*			C		2
plants	land plants	Orthotrichaceae	*Macromitrium aurescens*			C		2/2
plants	land plants	Oxalidaceae	*Oxalis*					2
plants	land plants	Oxalidaceae	*Oxalis radicosa*			C		4/1
plants	land plants	Passifloraceae	*Passiflora foetida*		Y			1/1
plants	land plants	Phyllanthaceae	*Bridelia leichhardtii*			C		1/1
plants	land plants	Phyllanthaceae	*Phyllanthus maderaspatensis*			C		3
plants	land plants	Phyllanthaceae	*Phyllanthus virgatus*			C		12
plants	land plants	Phyllanthaceae	*Phyllanthus sp. (Pentland R.J.Cumming 9742)*			C		2
plants	land plants	Phyllanthaceae	*Phyllanthus maderaspatensis var. maderaspatensis*			C		2
plants	land plants	Picrodendraceae	*Petalostigma pubescens*	quinine tree		C		10
plants	land plants	Pittosporaceae	*Pittosporum angustifolium*			C		1
plants	land plants	Pittosporaceae	*Bursaria spinosa subsp. spinosa*			C		1
plants	land plants	Plantaginaceae	*Scoparia dulcis*	scoparia	Y			2/1
plants	land plants	Poaceae	*Cenchrus pennisetiformis*		Y			1/1
plants	land plants	Poaceae	*Paspalidium albovillosum*			C		2/2
plants	land plants	Poaceae	*Bothriochloa erianthoides*	satintop grass		C		2
plants	land plants	Poaceae	*Cymbopogon queenslandicus*			C		1
plants	land plants	Poaceae	*Digitaria divaricatissima*	spreading umbrella grass		C		1/1
plants	land plants	Poaceae	*Thyridolepis mitchelliana*	mulga mitchell grass		C		1
plants	land plants	Poaceae	*Dichanthium queenslandicum*			V	E	2/2
plants	land plants	Poaceae	*Diplachne fusca var. fusca*			C		1/1
plants	land plants	Poaceae	*Eriochloa pseudoacrotricha*			C		25
plants	land plants	Poaceae	*Eragrostis longipedicellata*			C		2/2
plants	land plants	Poaceae	*Hyparrhenia rufa subsp. rufa*		Y			2/2
plants	land plants	Poaceae	*Cynodon dactylon var. dactylon*		Y			1
plants	land plants	Poaceae	*Aristida calycina var. praealta*			C		1/1
plants	land plants	Poaceae	*Dinebra decipiens var. peacockii*			C		1/1
plants	land plants	Poaceae	*Aristida benthamii var. benthamii*			C		1/1
plants	land plants	Poaceae	*Aristida holathera var. holathera*			C		4/3
plants	land plants	Poaceae	*Panicum decompositum var. tenuius*			C		1/1
plants	land plants	Poaceae	*Chloris divaricata var. divaricata*	slender chloris		C		3/1
plants	land plants	Poaceae	*Bothriochloa bladhii subsp. bladhii*			C		1/1

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plants	land plants	Poaceae	*Dichanthium sericeum subsp. sericeum*			C		5/2
plants	land plants	Poaceae	*Urochloa holosericea subsp. velutina*			C		1/1
plants	land plants	Poaceae	*Bothriochloa decipiens var. decipiens*			C		1/1
plants	land plants	Poaceae	*Aristida queenslandica var. dissimilis*			C		1
plants	land plants	Poaceae	*Panicum decompositum var. decompositum*			C		24/1
plants	land plants	Poaceae	*Panicum queenslandicum var. acuminatum*			C		2/2
plants	land plants	Poaceae	*Aristida jerichoensis var. jerichoensis*			C		1/1
plants	land plants	Poaceae	*Aristida jerichoensis var. subspinulifera*			C		3/3
plants	land plants	Poaceae	*Aristida queenslandica var. queenslandica*			C		1/1
plants	land plants	Poaceae	*Calyptochloa gracillima subsp. gracillima*			C		2/2
plants	land plants	Poaceae	*Panicum queenslandicum var. queenslandicum*			C		1/1
plants	land plants	Poaceae	*Eriachne mucronata forma (Alpha C.E.Hubbard 7882)*			C		2/2
plants	land plants	Poaceae	*Eragrostis sororia*			C		8/4
plants	land plants	Poaceae	*Eriachne mucronata*			C		1
plants	land plants	Poaceae	*Ophiuros exaltatus*			C		3
plants	land plants	Poaceae	*Aristida gracilipes*			C		1/1
plants	land plants	Poaceae	*Cymbopogon ambiguus*	lemon grass		C		3/1
plants	land plants	Poaceae	*Digitaria ammophila*	silky umbrella grass		C		10/2
plants	land plants	Poaceae	*Enteropogon ramosus*			C		4/1
plants	land plants	Poaceae	*Eragrostis elongata*			C		1
plants	land plants	Poaceae	*Eragrostis speciosa*			C		1/1
plants	land plants	Poaceae	*Leptochloa digitata*			C		2
plants	land plants	Poaceae	*Megathyrsus maximus*		Y			3
plants	land plants	Poaceae	*Paspalidium gracile*	slender panic		C		1
plants	land plants	Poaceae	*Sporobolus sessilis*			C		1
plants	land plants	Poaceae	*Bothriochloa pertusa*		Y			11/3
plants	land plants	Poaceae	*Cymbopogon refractus*	barbed-wire grass		C		1
plants	land plants	Poaceae	*Dichanthium fecundum*	curly bluegrass		C		1
plants	land plants	Poaceae	*Dichanthium sericeum*			C		32/1
plants	land plants	Poaceae	*Enneapogon truncatus*			C		22
plants	land plants	Poaceae	*Eragrostis lacunaria*	purple lovegrass		C		2/1
plants	land plants	Poaceae	*Eragrostis schultzii*			C		1/1
plants	land plants	Poaceae	*Eragrostis tenellula*	delicate lovegrass		C		11
plants	land plants	Poaceae	*Panicum decompositum*			C		3
plants	land plants	Poaceae	*Paspalum mandiocanum*		Y			1/1
plants	land plants	Poaceae	*Alloteropsis cimicina*			C		1/1
plants	land plants	Poaceae	*Cymbopogon bombycinus*	silky oilgrass		C		2
plants	land plants	Poaceae	*Dichanthium aristatum*	angleton grass	Y			2/2
plants	land plants	Poaceae	*Digitaria breviglumis*			C		1
plants	land plants	Poaceae	*Elytrophorus spicatus*			C		3
plants	land plants	Poaceae	*Eragrostis parviflora*	weeping lovegrass		C		6
plants	land plants	Poaceae	*Eremochloa bimaculata*	poverty grass		C		1/1
plants	land plants	Poaceae	*Heteropogon contortus*	black speargrass		C		23
plants	land plants	Poaceae	*Iseilema membranaceum*	small flinders grass		C		1/1
plants	land plants	Poaceae	*Iseilema vaginiflorum*	red flinders grass		C		34/1
plants	land plants	Poaceae	*Alloteropsis semialata*	cockatoo grass		C		2

Kingdom	Class	Family	Scientific Name	Common Name	I	Q	A	Records
plants	land plants	Poaceae	*Aristida queenslandica*			C		1
plants	land plants	Poaceae	*Bothriochloa ewartiana*	desert bluegrass		C		31/2
plants	land plants	Poaceae	*Brachyachne convergens*	common native couch		C		35
plants	land plants	Poaceae	*Enteropogon acicularis*	curly windmill grass		C		2
plants	land plants	Poaceae	*Enteropogon unispiceus*			C		1/1
plants	land plants	Poaceae	*Moorochloa eruciformis*		Y			9/1
plants	land plants	Poaceae	*Panicum queenslandicum*			C		8
plants	land plants	Poaceae	*Paspalidium criniforme*			C		2/1
plants	land plants	Poaceae	*Paspalidium globoideum*	sago grass		C		22/1
plants	land plants	Poaceae	*Setaria paspalidioides*			C		2/2
plants	land plants	Poaceae	*Urochloa mosambicensis*	sabi grass	Y			4/1
plants	land plants	Poaceae	*Ancistrachne uncinulata*	hooky grass		C		2/2
plants	land plants	Poaceae	*Dactyloctenium radulans*	button grass		C		3
plants	land plants	Poaceae	*Digitaria hystrichoides*	umbrella grass		C		1/1
plants	land plants	Poaceae	*Eragrostis leptostachya*			C		1
plants	land plants	Poaceae	*Eragrostis megalosperma*			C		2/2
plants	land plants	Poaceae	*Sporobolus actinocladus*	katoora grass		C		1/1
plants	land plants	Poaceae	*Poaceae*					3
plants	land plants	Poaceae	*Aristida*					6
plants	land plants	Poaceae	*Eriachne*					1/1
plants	land plants	Poaceae	*Digitaria*					1/1
plants	land plants	Poaceae	*Eragrostis*					6
plants	land plants	Poaceae	*Paspalidium*					1
plants	land plants	Poaceae	*Perotis rara*	comet grass		C		1/1
plants	land plants	Poaceae	*Eriachne rara*			C		1/1
plants	land plants	Poaceae	*Eulalia aurea*	silky browntop		C		1/1
plants	land plants	Poaceae	*Chloris gayana*	rhodes grass	Y			4
plants	land plants	Poaceae	*Melinis repens*	red natal grass	Y			17
plants	land plants	Poaceae	*Aristida ramosa*	purple wiregrass		C		2
plants	land plants	Poaceae	*Chloris inflata*	purpletop chloris	Y			12
plants	land plants	Poaceae	*Chloris virgata*	feathertop rhodes grass	Y			9
plants	land plants	Poaceae	*Eriachne obtusa*			C		4/1
plants	land plants	Poaceae	*Panicum effusum*			C		5/2
plants	land plants	Poaceae	*Sehima nervosum*			C		1/1
plants	land plants	Poaceae	*Setaria surgens*			C		1/1
plants	land plants	Poaceae	*Aristida ingrata*			C		1/1
plants	land plants	Poaceae	*Chloris truncata*			C		5
plants	land plants	Poaceae	*Digitaria orbata*			C		1
plants	land plants	Poaceae	*Eriochloa crebra*	spring grass		C		33/2
plants	land plants	Poaceae	*Themeda avenacea*			C		1
plants	land plants	Poaceae	*Themeda triandra*	kangaroo grass		C		20/1
plants	land plants	Poaceae	*Triraphis mollis*	purple plumegrass		C		1/1
plants	land plants	Poaceae	*Aristida muricata*			C		1/1
plants	land plants	Poaceae	*Astrebla lappacea*	curly mitchell grass		C		7
plants	land plants	Poaceae	*Cenchrus ciliaris*		Y			54/1
plants	land plants	Poaceae	*Chloris pectinata*	comb chloris		C		1/1

Kingdom	Class	Family	Scientific Name	Common Name	I	Q	A	Records
plants	land plants	Poaceae	*Digitaria brownii*			C		1/1
plants	land plants	Poaceae	*Digitaria papposa*			C		1/1
plants	land plants	Poaceae	*Enneapogon virens*			C		2/1
plants	land plants	Poaceae	*Entolasia stricta*	wiry panic		C		2
plants	land plants	Poaceae	*Eragrostis pilosa*	soft lovegrass	Y			1/1
plants	land plants	Poaceae	*Eriochloa procera*	slender cupgrass		C		3
plants	land plants	Poaceae	*Mnesithea formosa*			C		1/1
plants	land plants	Poaceae	*Sporobolus caroli*	fairy grass		C		5
plants	land plants	Poaceae	*Sporobolus creber*			C		15
plants	land plants	Poaceae	*Thellungia advena*	coolibah grass		C		5/2
plants	land plants	Poaceae	*Urochloa piligera*			C		2
plants	land plants	Poaceae	*Aristida benthamii*			C		3
plants	land plants	Poaceae	*Aristida latifolia*	feathertop wiregrass		C		32/4
plants	land plants	Poaceae	*Aristida leptopoda*	white speargrass		C		13/1
plants	land plants	Poaceae	*Aristida personata*			C		4
plants	land plants	Poaceae	*Astrebla elymoides*	hoop mitchell grass		C		4/1
plants	land plants	Poaceae	*Astrebla squarrosa*	bull mitchell grass		C		26
plants	land plants	Poaceae	*Chrysopogon fallax*			C		5/2
plants	land plants	Poaceae	*Digitaria bicornis*			C		1
plants	land plants	Poaceae	*Echinochloa colona*	awnless barnyard grass	Y			1
plants	land plants	Poaceae	*Eragrostis brownii*	Brown's lovegrass		C		3/1
plants	land plants	Polygalaceae	*Polygala crassitesta*			C		13
plants	land plants	Polygonaceae	*Persicaria attenuata*			C		2/1
plants	land plants	Pontederiaceae	*Monochoria cyanea*			C		5
plants	land plants	Portulacaceae	*Portulaca pilosa*		Y			1
plants	land plants	Portulacaceae	*Portulaca oleracea*	pigweed	Y			3
plants	land plants	Proteaceae	*Grevillea striata*	beefwood		C		1
plants	land plants	Proteaceae	*Persoonia amaliae*			C		2/1
plants	land plants	Proteaceae	*Persoonia falcata*			C		5
plants	land plants	Proteaceae	*Hakea chordophylla*			C		1
plants	land plants	Proteaceae	*Grevillea parallela*			C		1
plants	land plants	Proteaceae	*Grevillea*					2
plants	land plants	Proteaceae	*Grevillea pteridifolia*	golden parrot tree		C		2/1
plants	land plants	Proteaceae	*Hakea lorea subsp. lorea*			C		1
plants	land plants	Proteaceae	*Grevillea juncifolia*	honeysuckle spider flower		C		1
plants	land plants	Pteridaceae	*Cheilanthes sieberi subsp. sieberi*			C		2
plants	land plants	Pteridaceae	*Adiantum atroviride*			C		1/1
plants	land plants	Putranjivaceae	*Drypetes deplanchei*	grey boxwood		C		1
plants	land plants	Rhamnaceae	*Ventilago viminalis*	supplejack		C		8
plants	land plants	Rhamnaceae	*Alphitonia excelsa*	soap tree		C		5
plants	land plants	Rubiaceae	*Larsenaikia ochreata*			C		4/2
plants	land plants	Rubiaceae	*Oldenlandia mitrasacmoides subsp. trachymenoides*			C		7/1
plants	land plants	Rubiaceae	*Psydrax odorata subsp. australiana*			C		1/1
plants	land plants	Rubiaceae	*Oldenlandia coerulescens*			C		1/1
plants	land plants	Rubiaceae	*Psydrax oleifolia*			C		1
plants	land plants	Rubiaceae	*Pavetta australiensis var. australiensis - Pavetta granitica*			C		1/1

Kingdom	Class	Family	Scientific Name	Common Name	I	Q	A	Records
plants	land plants	Rubiaceae	*Oldenlandia galioides*			C		1/1
plants	land plants	Rubiaceae	*Richardia brasiliensis*	white eye	Y			1/1
plants	land plants	Rubiaceae	*Spermacoce brachystema*			C		2
plants	land plants	Rubiaceae	*Spermacoce multicaulis*			C		1
plants	land plants	Rutaceae	*Acronychia laevis*	glossy acronychia		C		1/1
plants	land plants	Rutaceae	*Geijera salicifolia*	brush wilga		C		1
plants	land plants	Rutaceae	*Murraya ovatifoliolata*			C		1/1
plants	land plants	Rutaceae	*Flindersia dissosperma*			C		5
plants	land plants	Santalaceae	*Santalum lanceolatum*			C		3
plants	land plants	Sapindaceae	*Alectryon oleifolius subsp. elongatus*			C		3
plants	land plants	Sapindaceae	*Alectryon diversifolius*	scrub boonaree		C		4
plants	land plants	Sapindaceae	*Dodonaea lanceolata*			C		2
plants	land plants	Sapindaceae	*Atalaya hemiglauca*			C		5
plants	land plants	Sapindaceae	*Atalaya*					5
plants	land plants	Sapotaceae	*Planchonella pohlmaniana*			C		1/1
plants	land plants	Scrophulariaceae	*Eremophila mitchellii*			C		4
plants	land plants	Scrophulariaceae	*Eremophila bignoniiflora*	eurah		C		1
plants	land plants	Scrophulariaceae	*Myoporum acuminatum*	coastal boobialla		C		3/2
plants	land plants	Scrophulariaceae	*Eremophila maculata*			C		7
plants	land plants	Scrophulariaceae	*Eremophila deserti*			C		3
plants	land plants	Scrophulariaceae	*Eremophila debilis*	winter apple		C		4
plants	land plants	Solanaceae	*Solanum esuriale*	quena		C		8
plants	land plants	Solanaceae	*Datura stramonium*	common thornapple	Y			3
plants	land plants	Solanaceae	*Solanum adenophorum*			E		1/1
plants	land plants	Solanaceae	*Solanum elachophyllum*			E		1/1
plants	land plants	Solanaceae	*Solanum parvifolium subsp. parvifolium*			C		2/2
plants	land plants	Sparrmanniaceae	*Grewia latifolia*	dysentery plant		C		4
plants	land plants	Sparrmanniaceae	*Corchorus trilocularis*			C		16/1
plants	land plants	Stylidiaceae	*Stylidium eglandulosum*			C		1/1
plants	land plants	Thymelaeaceae	*Pimelea haematostachya*			C		20/1
plants	land plants	Thymelaeaceae	*Pimelea microcephala*			C		1
plants	land plants	Verbenaceae	*Lantana camara*	lantana	Y			1
plants	land plants	Verbenaceae	*Verbena macrostachya*			C		1
plants	land plants	Verbenaceae	*Glandularia aristigera*		Y			1
plants	land plants	Violaceae	*Afrohybanthus enneaspermus*			C		1
plants	land plants	Zygophyllaceae	*Tribulus eichlerianus*	bull head		C		1
plants	land plants	Zygophyllaceae	*Tribulus terrestris*	caltrop		C		1

CODES

I - Y indicates that the taxon is introduced to Queensland and has naturalised.

Q - Indicates the Queensland conservation status of each taxon under the *Nature Conservation Act 1992.* The codes are Extinct in the Wild (PE), Endangered (E), Vulnerable (V), Near Threatened (NT), Least Concern (C) or Not Protected ( ).

A - Indicates the Australian conservation status of each taxon under the *Environment Protection and Biodiversity Conservation Act 1999.* The values of EPBC are Conservation Dependent (CD), Critically Endangered (CE), Endangered (E), Extinct (EX), Extinct in the Wild (XW) and Vulnerable (V).

Records – The first number indicates the total number of records of the taxon for the record option selected (i.e. All, Confirmed or Specimens).
This number is output as 99999 if it equals or exceeds this value. The second number located after the / indicates the number of specimen records for the taxon.
This number is output as 999 if it equals or exceeds this value.

Appendix B Laboratory Certificates of Analysis

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EB1913328**	Page	: 1 of 9
Client	: **ECOLOGICAL SERVICE PROFESSIONALS**	Laboratory	: Environmental Division Brisbane
Contact	: Kate Keating	Contact	: Customer Services EB
Address	: Unit 1 / 16 Industry Place, Wynnum, QLD, 4178 PO Box 5815, Manly, QLD, 4179 MANLY NSW, AUSTRALIA 4178	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: ----	Telephone	: +61-7-3243 7222
Project	: Winchester 1845	Date Samples Received	: 24-May-2019 09:10
Order number	:	Date Analysis Commenced	: 24-May-2019
C-O-C number	: ----	Issue Date	: 30-May-2019 13:12
Sampler	: REBECCA KING		
Site	: ----		
Quote number	: BN/445/17		
No. of samples received	: 9		
No. of samples analysed	: 9		

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

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

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results
- Surrogate Control Limits

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

Signatories

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

Signatories	*Position*	*Accreditation Category*
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD
Santusha Pandra	Organic Chemist	Brisbane Organics, Stafford, QLD

General Comments

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

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

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

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

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

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

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

- It is recognised that EG094-AgT (Low-Level Total Silver in Fresh Water by ORC-ICP-MS) is less than EG094-AgF (Low Level Dissolved Silver in Fresh Water by ORC-ICP-MS) for sample EB1913328-002(I1). However, the difference is within experimental variation of the methods.
- It is recognised that EG020T (Total Metals) is less than EG020F (Dissolved Metals) for some samples. However, the difference is within experimental variation of the methods.
- Sodium Adsorption Ratio (where reported): Where results for Na, Ca or Mg are <LOR, a concentration at half the reported LOR is incorporated into the SAR calculation. This represents a conservative approach for Na relative to the assumption that <LOR = zero concentration and a conservative approach for Ca & Mg relative to the assumption that <LOR is equivalent to the LOR concentration.

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	U1	I1	LWS	I2a R1	I2a R2
			Client sampling date / time	16-May-2019 00:00	16-May-2019 00:00	17-May-2019 00:00	19-May-2019 00:00	19-May-2019 00:00
Compound	CAS Number	LOR	Unit	EB1913328-001	EB1913328-002	EB1913328-003	EB1913328-004	EB1913328-005
				Result	Result	Result	Result	Result
EA015: Total Dissolved Solids dried at 180 ± 5 °C								
Total Dissolved Solids @180°C	----	10	mg/L	**168**	**185**	**185**	**207**	**224**
EA025: Total Suspended Solids dried at 104 ± 2°C								
Suspended Solids (SS)	----	5	mg/L	**20**	<5	<5	<5	<5
EA065: Total Hardness as CaCO3								
Total Hardness as CaCO3	----	1	mg/L	**67**	**104**	**82**	**103**	**103**
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	**3**	**6**	**2**	**6**	**6**
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	**17**	**25**	**18**	**23**	**23**
Magnesium	7439-95-4	1	mg/L	**6**	**10**	**9**	**11**	**11**
Sodium	7440-23-5	1	mg/L	**19**	**27**	**37**	**33**	**33**
Potassium	7440-09-7	1	mg/L	**6**	**3**	**6**	**5**	**5**
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	**0.01**	<0.01	<0.01	<0.01	<0.01
Arsenic	7440-38-2	0.001	mg/L	**0.001**	<0.001	<0.001	<0.001	<0.001
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L	**0.002**	<0.001	**0.001**	<0.001	<0.001
Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Nickel	7440-02-0	0.001	mg/L	**0.002**	**0.001**	<0.001	**0.001**	<0.001
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	7440-66-6	0.005	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005
Manganese	7439-96-5	0.001	mg/L	**0.004**	**0.006**	<0.001	**0.003**	**0.002**
Molybdenum	7439-98-7	0.001	mg/L	**0.001**	**0.001**	<0.001	<0.001	<0.001
Uranium	7440-61-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Boron	7440-42-8	0.05	mg/L	**0.06**	**0.06**	**0.14**	**0.05**	**0.05**
Iron	7439-89-6	0.05	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05
EG020T: Total Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	**1.35**	**0.19**	**0.57**	**0.26**	**0.22**
Arsenic	7440-38-2	0.001	mg/L	**0.002**	**0.001**	<0.001	<0.001	<0.001
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	7440-47-3	0.001	mg/L	**0.002**	<0.001	<0.001	<0.001	<0.001

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	U1	I1	LWS	I2a R1	I2a R2
				Client sampling date / time	16-May-2019 00:00	16-May-2019 00:00	17-May-2019 00:00	19-May-2019 00:00	19-May-2019 00:00
Compound	CAS Number	LOR	Unit		EB1913328-001	EB1913328-002	EB1913328-003	EB1913328-004	EB1913328-005
					Result	Result	Result	Result	Result
EG020T: Total Metals by ICP-MS - Continued									
Copper	7440-50-8	0.001	mg/L		**0.002**	<0.001	**0.002**	<0.001	<0.001
Cobalt	7440-48-4	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Nickel	7440-02-0	0.001	mg/L		**0.004**	**0.002**	**0.001**	**0.001**	**0.001**
Lead	7439-92-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Selenium	7782-49-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	7440-66-6	0.005	mg/L		<0.005	<0.005	<0.005	<0.005	**0.005**
Manganese	7439-96-5	0.001	mg/L		**0.028**	**0.048**	**0.020**	**0.021**	**0.018**
Molybdenum	7439-98-7	0.001	mg/L		**0.001**	**0.001**	<0.001	<0.001	<0.001
Uranium	7440-61-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Vanadium	7440-62-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Boron	7440-42-8	0.05	mg/L		<0.05	<0.05	**0.11**	<0.05	<0.05
Iron	7439-89-6	0.05	mg/L		**1.40**	**0.14**	**0.42**	**0.20**	**0.22**
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EG035T: Total Recoverable Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EG094F: Dissolved Metals in Fresh Water by ORC-ICPMS									
Silver	7440-22-4	0.01	µg/L		<0.01	**0.02**	<0.01	<0.01	<0.01
EG094T: Total metals in Fresh water by ORC-ICPMS									
Silver	7440-22-4	0.01	µg/L		<0.01	<0.01	<0.01	<0.01	<0.01
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L		**0.3**	**0.2**	**0.8**	**0.2**	**0.2**
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L		**0.02**	**0.03**	**0.02**	**0.03**	**0.02**
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L		**0.8**	**0.2**	**0.3**	**0.2**	**0.2**
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	U1	I1	LWS	I2a R1	I2a R2
				Client sampling date / time	16-May-2019 00:00	16-May-2019 00:00	17-May-2019 00:00	19-May-2019 00:00	19-May-2019 00:00
Compound	CAS Number	LOR	Unit		EB1913328-001	EB1913328-002	EB1913328-003	EB1913328-004	EB1913328-005
					Result	Result	Result	Result	Result
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser - Continued									
^ **Total Nitrogen as N**	----	0.1	mg/L		**0.8**	**0.2**	**0.3**	**0.2**	**0.2**
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		**0.06**	<0.01	<0.01	<0.01	<0.01
EK071G: Reactive Phosphorus as P by discrete analyser									
Reactive Phosphorus as P	14265-44-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
EP080/071: Total Petroleum Hydrocarbons									
C6 - C9 Fraction	----	20	µg/L		<20	<20	<20	<20	<20
C10 - C14 Fraction	----	50	µg/L		<50	<50	<50	<50	<50
C15 - C28 Fraction	----	100	µg/L		<100	<100	<100	<100	<100
C29 - C36 Fraction	----	50	µg/L		<50	<50	<50	<50	<50
^ **C10 - C36 Fraction (sum)**	----	50	µg/L		<50	<50	<50	<50	<50
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions									
C6 - C10 Fraction	C6_C10	20	µg/L		<20	<20	<20	<20	<20
^ **C6 - C10 Fraction minus BTEX (F1)**	C6_C10-BTEX	20	µg/L		<20	<20	<20	<20	<20
>C10 - C16 Fraction	----	100	µg/L		<100	<100	<100	<100	<100
>C16 - C34 Fraction	----	100	µg/L		<100	<100	<100	<100	<100
>C34 - C40 Fraction	----	100	µg/L		<100	<100	<100	<100	<100
^ **>C10 - C40 Fraction (sum)**	----	100	µg/L		<100	<100	<100	<100	<100
^ **>C10 - C16 Fraction minus Naphthalene (F2)**	----	100	µg/L		<100	<100	<100	<100	<100
EP080: BTEXN									
Benzene	71-43-2	1	µg/L		<1	<1	<1	<1	<1
Toluene	108-88-3	2	µg/L		<2	<2	<2	<2	<2
Ethylbenzene	100-41-4	2	µg/L		<2	<2	<2	<2	<2
meta- & para-Xylene	108-38-3 106-42-3	2	µg/L		<2	<2	<2	<2	<2
ortho-Xylene	95-47-6	2	µg/L		<2	<2	<2	<2	<2
^ **Total Xylenes**	----	2	µg/L		<2	<2	<2	<2	<2
^ **Sum of BTEX**	----	1	µg/L		<1	<1	<1	<1	<1
Naphthalene	91-20-3	5	µg/L		<5	<5	<5	<5	<5
EP080S: TPH(V)/BTEX Surrogates									
1.2-Dichloroethane-D4	17060-07-0	2	%		**97.4**	**98.7**	**95.9**	**98.6**	**97.8**
Toluene-D8	2037-26-5	2	%		**99.4**	**99.4**	**96.0**	**99.2**	**99.9**
4-Bromofluorobenzene	460-00-4	2	%		**108**	**106**	**102**	**110**	**107**

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	I3 R1	I3 R2	U4	RCT4	----
				Client sampling date / time	19-May-2019 00:00	19-May-2019 00:00	20-May-2019 00:00	20-May-2019 00:00	----
Compound	CAS Number	LOR	Unit		EB1913328-006	EB1913328-007	EB1913328-008	EB1913328-009	--------
					Result	Result	Result	Result	----
EA015: Total Dissolved Solids dried at 180 ± 5 °C									
Total Dissolved Solids @180°C	----	10	mg/L		151	<10	261	234	----
EA025: Total Suspended Solids dried at 104 ± 2°C									
Suspended Solids (SS)	----	5	mg/L		26	<5	186	46	----
EA065: Total Hardness as CaCO3									
Total Hardness as CaCO3	----	1	mg/L		73	<1	141	125	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L		4	<1	1	4	----
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L		16	<1	40	37	----
Magnesium	7439-95-4	1	mg/L		8	<1	10	8	----
Sodium	7440-23-5	1	mg/L		26	<1	32	11	----
Potassium	7440-09-7	1	mg/L		4	<1	6	13	----
EG020F: Dissolved Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	----
Arsenic	7440-38-2	0.001	mg/L		<0.001	<0.001	0.001	<0.001	----
Cadmium	7440-43-9	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	----
Chromium	7440-47-3	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	----
Copper	7440-50-8	0.001	mg/L		<0.001	0.001	0.005	0.004	----
Cobalt	7440-48-4	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	----
Nickel	7440-02-0	0.001	mg/L		0.001	<0.001	0.003	0.002	----
Lead	7439-92-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	----
Selenium	7782-49-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	----
Zinc	7440-66-6	0.005	mg/L		<0.005	<0.005	<0.005	<0.005	----
Manganese	7439-96-5	0.001	mg/L		0.011	<0.001	0.045	0.003	----
Molybdenum	7439-98-7	0.001	mg/L		<0.001	<0.001	0.002	0.001	----
Uranium	7440-61-1	0.001	mg/L		<0.001	<0.001	0.003	<0.001	----
Vanadium	7440-62-2	0.01	mg/L		<0.01	<0.01	0.01	0.01	----
Boron	7440-42-8	0.05	mg/L		0.06	<0.05	0.11	0.07	----
Iron	7439-89-6	0.05	mg/L		<0.05	<0.05	<0.05	<0.05	----
EG020T: Total Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L		0.73	<0.01	11.1	5.74	----
Arsenic	7440-38-2	0.001	mg/L		0.001	<0.001	0.002	0.002	----
Cadmium	7440-43-9	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	----
Chromium	7440-47-3	0.001	mg/L		<0.001	<0.001	0.009	0.008	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	I3 R1	I3 R2	U4	RCT4	----
				Client sampling date / time	19-May-2019 00:00	19-May-2019 00:00	20-May-2019 00:00	20-May-2019 00:00	----
Compound	CAS Number	LOR	Unit		EB1913328-006	EB1913328-007	EB1913328-008	EB1913328-009	--------
					Result	Result	Result	Result	----
EG020T: Total Metals by ICP-MS - Continued									
Copper	7440-50-8	0.001	mg/L		**0.001**	<0.001	**0.013**	**0.008**	----
Cobalt	7440-48-4	0.001	mg/L		**0.001**	<0.001	**0.005**	**0.003**	----
Nickel	7440-02-0	0.001	mg/L		**0.002**	<0.001	**0.010**	**0.008**	----
Lead	7439-92-1	0.001	mg/L		<0.001	<0.001	**0.003**	**0.002**	----
Selenium	7782-49-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	----
Zinc	7440-66-6	0.005	mg/L		<0.005	<0.005	**0.017**	**0.006**	----
Manganese	7439-96-5	0.001	mg/L		**0.215**	<0.001	**0.237**	**0.165**	----
Molybdenum	7439-98-7	0.001	mg/L		<0.001	<0.001	**0.001**	**0.001**	----
Uranium	7440-61-1	0.001	mg/L		<0.001	<0.001	**0.003**	<0.001	----
Vanadium	7440-62-2	0.01	mg/L		<0.01	<0.01	**0.03**	**0.02**	----
Boron	7440-42-8	0.05	mg/L		<0.05	<0.05	**0.10**	**0.06**	----
Iron	7439-89-6	0.05	mg/L		**1.21**	<0.05	**8.20**	**4.74**	----
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	----
EG035T: Total Recoverable Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	----
EG094F: Dissolved Metals in Fresh Water by ORC-ICPMS									
Silver	7440-22-4	0.01	µg/L		<0.01	<0.01	<0.01	<0.01	----
EG094T: Total metals in Fresh water by ORC-ICPMS									
Silver	7440-22-4	0.01	µg/L		<0.01	<0.01	**0.03**	<0.01	----
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L		**0.2**	<0.1	**0.5**	**0.3**	----
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L		**0.02**	<0.01	**0.02**	**0.02**	----
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	----
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L		<0.01	<0.01	<0.01	**0.41**	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		<0.01	<0.01	<0.01	**0.41**	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L		**0.4**	<0.1	**2.1**	**1.3**	----
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	I3 R1	I3 R2	U4	RCT4	----
				Client sampling date / time	19-May-2019 00:00	19-May-2019 00:00	20-May-2019 00:00	20-May-2019 00:00	----
Compound	CAS Number	LOR	Unit		EB1913328-006	EB1913328-007	EB1913328-008	EB1913328-009	--------
					Result	Result	Result	Result	----
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser - Continued									
^ **Total Nitrogen as N**	----	0.1	mg/L		**0.4**	<0.1	**2.1**	**1.7**	----
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		**0.04**	<0.01	**0.29**	**0.12**	----
EK071G: Reactive Phosphorus as P by discrete analyser									
Reactive Phosphorus as P	14265-44-2	0.01	mg/L		<0.01	<0.01	**0.03**	<0.01	----
EP080/071: Total Petroleum Hydrocarbons									
C6 - C9 Fraction	----	20	µg/L		<20	<20	<20	<20	----
C10 - C14 Fraction	----	50	µg/L		<50	<50	<50	<50	----
C15 - C28 Fraction	----	100	µg/L		<100	<100	<100	<100	----
C29 - C36 Fraction	----	50	µg/L		<50	<50	<50	<50	----
^ **C10 - C36 Fraction (sum)**	----	50	µg/L		<50	<50	<50	<50	----
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions									
C6 - C10 Fraction	C6_C10	20	µg/L		<20	<20	<20	<20	----
^ **C6 - C10 Fraction minus BTEX (F1)**	C6_C10-BTEX	20	µg/L		<20	<20	<20	<20	----
>C10 - C16 Fraction	----	100	µg/L		<100	<100	<100	<100	----
>C16 - C34 Fraction	----	100	µg/L		<100	<100	<100	<100	----
>C34 - C40 Fraction	----	100	µg/L		<100	<100	<100	<100	----
^ **>C10 - C40 Fraction (sum)**	----	100	µg/L		<100	<100	<100	<100	----
^ **>C10 - C16 Fraction minus Naphthalene (F2)**	----	100	µg/L		<100	<100	<100	<100	----
EP080: BTEXN									
Benzene	71-43-2	1	µg/L		<1	<1	<1	<1	----
Toluene	108-88-3	2	µg/L		<2	<2	<2	<2	----
Ethylbenzene	100-41-4	2	µg/L		<2	<2	<2	<2	----
meta- & para-Xylene	108-38-3 106-42-3	2	µg/L		<2	<2	<2	<2	----
ortho-Xylene	95-47-6	2	µg/L		<2	<2	<2	<2	----
^ **Total Xylenes**	----	2	µg/L		<2	<2	<2	<2	----
^ **Sum of BTEX**	----	1	µg/L		<1	<1	<1	<1	----
Naphthalene	91-20-3	5	µg/L		<5	<5	<5	<5	----
EP080S: TPH(V)/BTEX Surrogates									
1.2-Dichloroethane-D4	17060-07-0	2	%		**99.1**	**97.6**	**97.4**	**97.7**	----
Toluene-D8	2037-26-5	2	%		**100**	**100**	**99.0**	**99.0**	----
4-Bromofluorobenzene	460-00-4	2	%		**110**	**108**	**108**	**107**	----

Surrogate Control Limits

Sub-Matrix: **WATER**

Compound	CAS Number	Recovery Limits (%) Low	High
EP080S: TPH(V)/BTEX Surrogates			
1.2-Dichloroethane-D4	17060-07-0	66	138
Toluene-D8	2037-26-5	79	120
4-Bromofluorobenzene	460-00-4	74	118

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EB1913346**	Page	: 1 of 9
Client	: **ECOLOGICAL SERVICE PROFESSIONALS**	Laboratory	: Environmental Division Brisbane
Contact	: Kate Keating	Contact	: Customer Services EB
Address	: Unit 1 / 16 Industry Place, Wynnum, QLD, 4178 PO Box 5815, Manly, QLD, 4179 MANLY NSW, AUSTRALIA 4178	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: ----	Telephone	: +61-7-3243 7222
Project	: Winchester 1845	Date Samples Received	: 24-May-2019 09:10
Order number	:	Date Analysis Commenced	: 25-May-2019
C-O-C number	: ----	Issue Date	: 30-May-2019 12:45
Sampler	: REBECCA KING		
Site	: ----		
Quote number	: EN/222		
No. of samples received	: 13		
No. of samples analysed	: 13		

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

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

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results
- Surrogate Control Limits

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

Signatories

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

Signatories	*Position*	*Accreditation Category*
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD
Santusha Pandra	Organic Chemist	Brisbane Organics, Stafford, QLD

General Comments

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

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

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

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

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

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

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

- EG005T (Total Metals): Sample EB1913346-002 shows poor matrix spike recovery due to sample heterogeneity. Confirmed by visual inspection.

Analytical Results

Sub-Matrix: SEDIMENT (Matrix: SOIL)			Client sample ID	U1	I1	LWS	I2a R1	I2a R2
			Client sampling date / time	16-May-2019 00:00	16-May-2019 00:00	17-May-2019 00:00	19-May-2019 00:00	19-May-2019 00:00
Compound	CAS Number	LOR	Unit	EB1913346-001	EB1913346-002	EB1913346-003	EB1913346-004	EB1913346-005
				Result	Result	Result	Result	Result
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	1.0	%	32.0	36.9	38.0	22.3	23.2
EG005(ED093)T: Total Metals by ICP-AES								
Aluminium	7429-90-5	50	mg/kg	4360	3730	9470	1340	490
Arsenic	7440-38-2	5	mg/kg	<5	<5	6	<5	<5
Barium	7440-39-3	10	mg/kg	80	70	320	20	<10
Beryllium	7440-41-7	1	mg/kg	<1	<1	<1	<1	<1
Boron	7440-42-8	50	mg/kg	<50	<50	<50	<50	<50
Cadmium	7440-43-9	1	mg/kg	<1	<1	<1	<1	<1
Chromium	7440-47-3	2	mg/kg	12	12	44	6	5
Cobalt	7440-48-4	2	mg/kg	8	6	15	2	<2
Copper	7440-50-8	5	mg/kg	8	8	22	<5	<5
Iron	7439-89-6	50	mg/kg	14500	11800	26000	5290	2950
Lead	7439-92-1	5	mg/kg	10	6	15	<5	<5
Manganese	7439-96-5	5	mg/kg	210	217	758	85	28
Molybdenum	7439-98-7	2	mg/kg	<2	<2	<2	<2	<2
Nickel	7440-02-0	2	mg/kg	13	12	28	4	2
Selenium	7782-49-2	5	mg/kg	<5	<5	<5	<5	<5
Vanadium	7440-62-2	5	mg/kg	26	19	70	9	6
Zinc	7440-66-6	5	mg/kg	12	16	18	7	<5
EG020T: Total Metals by ICP-MS								
Silver	7440-22-4	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Uranium	7440-61-1	0.1	mg/kg	0.3	0.2	0.5	<0.1	<0.1
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
EP080/071: Total Petroleum Hydrocarbons								
C6 - C9 Fraction	----	10	mg/kg	<10	<10	<10	<10	<10
C10 - C14 Fraction	----	50	mg/kg	<50	<50	<50	<50	<50
C15 - C28 Fraction	----	100	mg/kg	<100	<100	<100	<100	<100
C29 - C36 Fraction	----	100	mg/kg	<100	<100	<100	<100	<100
^ C10 - C36 Fraction (sum)	----	50	mg/kg	<50	<50	<50	<50	<50
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions								
C6 - C10 Fraction	C6_C10	10	mg/kg	<10	<10	<10	<10	<10
^ C6 - C10 Fraction minus BTEX (F1)	C6_C10-BTEX	10	mg/kg	<10	<10	<10	<10	<10

Analytical Results

Sub-Matrix: SEDIMENT (Matrix: SOIL)				Client sample ID	U1	I1	LWS	I2a R1	I2a R2
				Client sampling date / time	16-May-2019 00:00	16-May-2019 00:00	17-May-2019 00:00	19-May-2019 00:00	19-May-2019 00:00
Compound	CAS Number	LOR	Unit		EB1913346-001	EB1913346-002	EB1913346-003	EB1913346-004	EB1913346-005
					Result	Result	Result	Result	Result
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions - Continued									
>C10 - C16 Fraction	----	50	mg/kg		<50	<50	<50	<50	<50
>C16 - C34 Fraction	----	100	mg/kg		<100	<100	<100	<100	<100
>C34 - C40 Fraction	----	100	mg/kg		<100	<100	<100	<100	<100
^ **>C10 - C40 Fraction (sum)**	----	50	mg/kg		<50	<50	<50	<50	<50
^ **>C10 - C16 Fraction minus Naphthalene (F2)**	----	50	mg/kg		<50	<50	<50	<50	<50
EP080: BTEXN									
Benzene	71-43-2	0.2	mg/kg		<0.2	<0.2	<0.2	<0.2	<0.2
Toluene	108-88-3	0.5	mg/kg		<0.5	<0.5	<0.5	<0.5	<0.5
Ethylbenzene	100-41-4	0.5	mg/kg		<0.5	<0.5	<0.5	<0.5	<0.5
meta- & para-Xylene	108-38-3 106-42-3	0.5	mg/kg		<0.5	<0.5	<0.5	<0.5	<0.5
ortho-Xylene	95-47-6	0.5	mg/kg		<0.5	<0.5	<0.5	<0.5	<0.5
^ **Sum of BTEX**	----	0.2	mg/kg		<0.2	<0.2	<0.2	<0.2	<0.2
^ **Total Xylenes**	----	0.5	mg/kg		<0.5	<0.5	<0.5	<0.5	<0.5
Naphthalene	91-20-3	1	mg/kg		<1	<1	<1	<1	<1
EP080S: TPH(V)/BTEX Surrogates									
1.2-Dichloroethane-D4	17060-07-0	0.2	%		**76.6**	**77.9**	**78.7**	**79.9**	**85.3**
Toluene-D8	2037-26-5	0.2	%		**70.6**	**72.6**	**78.4**	**73.0**	**78.8**
4-Bromofluorobenzene	460-00-4	0.2	%		**93.5**	**92.4**	**95.9**	**95.2**	**98.3**

Analytical Results

Sub-Matrix: SEDIMENT (Matrix: SOIL)				Client sample ID	I3	U4	RCT4	U3	RC1
				Client sampling date / time	19-May-2019 00:00	20-May-2019 00:00	20-May-2019 00:00	15-May-2019 00:00	17-May-2019 00:00
Compound	CAS Number	LOR	Unit		EB1913346-006	EB1913346-007	EB1913346-008	EB1913346-009	EB1913346-010
					Result	Result	Result	Result	Result
EA055: Moisture Content (Dried @ 105-110°C)									
Moisture Content	----	1.0	%		19.6	33.0	57.1	6.4	1.0
EG005(ED093)T: Total Metals by ICP-AES									
Aluminium	7429-90-5	50	mg/kg		760	13000	17000	13300	1280
Arsenic	7440-38-2	5	mg/kg		<5	<5	5	<5	<5
Barium	7440-39-3	10	mg/kg		10	330	390	440	50
Beryllium	7440-41-7	1	mg/kg		<1	1	1	1	<1
Boron	7440-42-8	50	mg/kg		<50	<50	<50	<50	<50
Cadmium	7440-43-9	1	mg/kg		<1	<1	<1	<1	<1
Chromium	7440-47-3	2	mg/kg		6	24	41	24	11
Cobalt	7440-48-4	2	mg/kg		<2	23	17	18	4
Copper	7440-50-8	5	mg/kg		<5	22	29	20	<5
Iron	7439-89-6	50	mg/kg		3660	30100	30000	19100	16000
Lead	7439-92-1	5	mg/kg		<5	26	14	18	10
Manganese	7439-96-5	5	mg/kg		38	1520	1120	1520	201
Molybdenum	7439-98-7	2	mg/kg		<2	<2	<2	<2	<2
Nickel	7440-02-0	2	mg/kg		2	23	37	25	6
Selenium	7782-49-2	5	mg/kg		<5	<5	<5	<5	<5
Vanadium	7440-62-2	5	mg/kg		8	73	84	70	21
Zinc	7440-66-6	5	mg/kg		<5	25	27	11	8
EG020T: Total Metals by ICP-MS									
Silver	7440-22-4	0.1	mg/kg		<0.1	<0.1	<0.1	<0.1	<0.1
Uranium	7440-61-1	0.1	mg/kg		<0.1	0.5	0.3	0.3	0.1
EG035T: Total Recoverable Mercury by FIMS									
Mercury	7439-97-6	0.1	mg/kg		<0.1	<0.1	<0.1	<0.1	<0.1
EP080/071: Total Petroleum Hydrocarbons									
C6 - C9 Fraction	----	10	mg/kg		<10	<10	<10	<10	<10
C10 - C14 Fraction	----	50	mg/kg		<50	<50	<50	<50	<50
C15 - C28 Fraction	----	100	mg/kg		<100	<100	<100	<100	<100
C29 - C36 Fraction	----	100	mg/kg		<100	<100	<100	<100	<100
^ C10 - C36 Fraction (sum)	----	50	mg/kg		<50	<50	<50	<50	<50
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions									
C6 - C10 Fraction	C6_C10	10	mg/kg		<10	<10	<10	<10	<10
^ C6 - C10 Fraction minus BTEX (F1)	C6_C10-BTEX	10	mg/kg		<10	<10	<10	<10	<10

Analytical Results

Sub-Matrix: SEDIMENT (Matrix: SOIL)				Client sample ID	I3	U4	RCT4	U3	RC1
				Client sampling date / time	19-May-2019 00:00	20-May-2019 00:00	20-May-2019 00:00	15-May-2019 00:00	17-May-2019 00:00
Compound	CAS Number	LOR	Unit		EB1913346-006	EB1913346-007	EB1913346-008	EB1913346-009	EB1913346-010
					Result	Result	Result	Result	Result
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions - Continued									
>C10 - C16 Fraction	----	50	mg/kg		<50	<50	<50	<50	<50
>C16 - C34 Fraction	----	100	mg/kg		<100	<100	<100	<100	<100
>C34 - C40 Fraction	----	100	mg/kg		<100	<100	<100	<100	<100
^ **>C10 - C40 Fraction (sum)**	----	50	mg/kg		<50	<50	<50	<50	<50
^ **>C10 - C16 Fraction minus Naphthalene (F2)**	----	50	mg/kg		<50	<50	<50	<50	<50
EP080: BTEXN									
Benzene	71-43-2	0.2	mg/kg		<0.2	<0.2	<0.2	<0.2	<0.2
Toluene	108-88-3	0.5	mg/kg		<0.5	<0.5	<0.5	<0.5	<0.5
Ethylbenzene	100-41-4	0.5	mg/kg		<0.5	<0.5	<0.5	<0.5	<0.5
meta- & para-Xylene	108-38-3 106-42-3	0.5	mg/kg		<0.5	<0.5	<0.5	<0.5	<0.5
ortho-Xylene	95-47-6	0.5	mg/kg		<0.5	<0.5	<0.5	<0.5	<0.5
^ **Sum of BTEX**	----	0.2	mg/kg		<0.2	<0.2	<0.2	<0.2	<0.2
^ **Total Xylenes**	----	0.5	mg/kg		<0.5	<0.5	<0.5	<0.5	<0.5
Naphthalene	91-20-3	1	mg/kg		<1	<1	<1	<1	<1
EP080S: TPH(V)/BTEX Surrogates									
1.2-Dichloroethane-D4	17060-07-0	0.2	%		**80.6**	**85.0**	**69.2**	**86.9**	**81.2**
Toluene-D8	2037-26-5	0.2	%		**74.9**	**77.8**	**62.1**	**81.4**	**79.1**
4-Bromofluorobenzene	460-00-4	0.2	%		**93.7**	**95.4**	**80.6**	**100**	**99.0**

Analytical Results

Sub-Matrix: SEDIMENT (Matrix: SOIL)				Client sample ID	U2	PW4	PW1	----	----
				Client sampling date / time	18-May-2019 00:00	18-May-2019 00:00	18-May-2019 00:00	----	----
Compound	CAS Number	LOR	Unit		EB1913346-011	EB1913346-012	EB1913346-013	--------	--------
					Result	Result	Result	----	----
EA055: Moisture Content (Dried @ 105-110°C)									
Moisture Content	----	1.0	%		7.1	8.2	6.7	----	----
EG005(ED093)T: Total Metals by ICP-AES									
Aluminium	7429-90-5	50	mg/kg		10800	8160	5310	----	----
Arsenic	7440-38-2	5	mg/kg		<5	<5	<5	----	----
Barium	7440-39-3	10	mg/kg		540	200	140	----	----
Beryllium	7440-41-7	1	mg/kg		<1	1	<1	----	----
Boron	7440-42-8	50	mg/kg		<50	<50	<50	----	----
Cadmium	7440-43-9	1	mg/kg		<1	<1	<1	----	----
Chromium	7440-47-3	2	mg/kg		14	21	17	----	----
Cobalt	7440-48-4	2	mg/kg		18	11	6	----	----
Copper	7440-50-8	5	mg/kg		31	24	13	----	----
Iron	7439-89-6	50	mg/kg		24500	18200	13900	----	----
Lead	7439-92-1	5	mg/kg		22	16	10	----	----
Manganese	7439-96-5	5	mg/kg		1920	256	240	----	----
Molybdenum	7439-98-7	2	mg/kg		<2	<2	<2	----	----
Nickel	7440-02-0	2	mg/kg		16	19	14	----	----
Selenium	7782-49-2	5	mg/kg		<5	<5	<5	----	----
Vanadium	7440-62-2	5	mg/kg		67	45	30	----	----
Zinc	7440-66-6	5	mg/kg		23	35	32	----	----
EG020T: Total Metals by ICP-MS									
Silver	7440-22-4	0.1	mg/kg		<0.1	<0.1	<0.1	----	----
Uranium	7440-61-1	0.1	mg/kg		0.5	0.7	0.4	----	----
EG035T: Total Recoverable Mercury by FIMS									
Mercury	7439-97-6	0.1	mg/kg		<0.1	<0.1	<0.1	----	----
EP080/071: Total Petroleum Hydrocarbons									
C6 - C9 Fraction	----	10	mg/kg		<10	<10	<10	----	----
C10 - C14 Fraction	----	50	mg/kg		<50	<50	430	----	----
C15 - C28 Fraction	----	100	mg/kg		<100	<100	1570	----	----
C29 - C36 Fraction	----	100	mg/kg		<100	<100	890	----	----
^ C10 - C36 Fraction (sum)	----	50	mg/kg		<50	<50	2890	----	----
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions									
C6 - C10 Fraction	C6_C10	10	mg/kg		<10	<10	<10	----	----
^ C6 - C10 Fraction minus BTEX (F1)	C6_C10-BTEX	10	mg/kg		<10	<10	<10	----	----

Analytical Results

Sub-Matrix: SEDIMENT (Matrix: SOIL)				Client sample ID	U2	PW4	PW1	----	----
				Client sampling date / time	18-May-2019 00:00	18-May-2019 00:00	18-May-2019 00:00	----	----
Compound	CAS Number	LOR	Unit		EB1913346-011	EB1913346-012	EB1913346-013	--------	--------
					Result	Result	Result	----	----
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions - Continued									
>C10 - C16 Fraction	----	50	mg/kg		<50	<50	**450**	----	----
>C16 - C34 Fraction	----	100	mg/kg		<100	**110**	**2170**	----	----
>C34 - C40 Fraction	----	100	mg/kg		<100	<100	**400**	----	----
^ **>C10 - C40 Fraction (sum)**	----	50	mg/kg		<50	**110**	**3020**	----	----
^ **>C10 - C16 Fraction minus Naphthalene (F2)**	----	50	mg/kg		<50	<50	**450**	----	----
EP080: BTEXN									
Benzene	71-43-2	0.2	mg/kg		<0.2	<0.2	<0.2	----	----
Toluene	108-88-3	0.5	mg/kg		<0.5	<0.5	<0.5	----	----
Ethylbenzene	100-41-4	0.5	mg/kg		<0.5	<0.5	<0.5	----	----
meta- & para-Xylene	108-38-3 106-42-3	0.5	mg/kg		<0.5	<0.5	<0.5	----	----
ortho-Xylene	95-47-6	0.5	mg/kg		<0.5	<0.5	<0.5	----	----
^ **Sum of BTEX**	----	0.2	mg/kg		<0.2	<0.2	<0.2	----	----
^ **Total Xylenes**	----	0.5	mg/kg		<0.5	<0.5	<0.5	----	----
Naphthalene	91-20-3	1	mg/kg		<1	<1	<1	----	----
EP080S: TPH(V)/BTEX Surrogates									
1.2-Dichloroethane-D4	17060-07-0	0.2	%		**77.2**	**75.5**	**84.1**	----	----
Toluene-D8	2037-26-5	0.2	%		**78.1**	**82.0**	**85.4**	----	----
4-Bromofluorobenzene	460-00-4	0.2	%		**98.2**	**97.1**	**99.8**	----	----

Surrogate Control Limits

Sub-Matrix: **SEDIMENT**

Compound	CAS Number	Recovery Limits (%) Low	High
EP080S: TPH(V)/BTEX Surrogates			
1.2-Dichloroethane-D4	17060-07-0	53	134
Toluene-D8	2037-26-5	60	131
4-Bromofluorobenzene	460-00-4	59	127

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EB1927891**	Page	: 1 of 17
Client	: **ECOLOGICAL SERVICE PROFESSIONALS**	Laboratory	: Environmental Division Brisbane
Contact	: Kate Keating	Contact	: Customer Services EB
Address	: Unit 1 / 16 Industry Place, Wynnum, QLD, 4178 PO Box 5815, Manly, QLD, 4179 MANLY NSW, AUSTRALIA 4178	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: ----	Telephone	: +61-7-3243 7222
Project	: Winchester 1845	Date Samples Received	: 21-Oct-2019 17:50
Order number	: ----	Date Analysis Commenced	: 21-Oct-2019
C-O-C number	: ----	Issue Date	: 29-Oct-2019 14:56
Sampler	: REBECCA KING		
Site	: ----		
Quote number	: BN/445/17		
No. of samples received	: 22		
No. of samples analysed	: 22		

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

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

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results
- Surrogate Control Limits

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

Signatories

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

Signatories	*Position*	*Accreditation Category*
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD
Matt Frost	Assistant Laboratory Manager	Brisbane Inorganics, Stafford, QLD
Matt Frost	Assistant Laboratory Manager	Brisbane Organics, Stafford, QLD
Sarah Ashworth	Laboratory Manager - Brisbane	Brisbane Inorganics, Stafford, QLD
Sarah Ashworth	Laboratory Manager - Brisbane	Brisbane Organics, Stafford, QLD

General Comments

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

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

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

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

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

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

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

- EG005T (Total Metals): Sample EB1927887-002 shows poor duplicate results due to sample heterogeneity. Confirmed by visual inspection.
- EG005T (Total Metals): Sample EB1927891-007 (I1) shows poor duplicate results due to sample heterogeneity. Confirmed by visual inspection.
- EG005T (Total Metals): Sample EB1927891-013 (U2) shows poor duplicate results due to sample heterogeneity. Confirmed by visual inspection.
- It is recognised that EG020-T (Total Metals by ICP-MS) is less than EG020-F (Dissolved Metals by ICP-MS) for some samples. However, the difference is within experimental variation of the methods.
- Sodium Adsorption Ratio (where reported): Where results for Na, Ca or Mg are <LOR, a concentration at half the reported LOR is incorporated into the SAR calculation. This represents a conservative approach for Na relative to the assumption that <LOR = zero concentration and a conservative approach for Ca & Mg relative to the assumption that <LOR is equivalent to the LOR concentration.

Analytical Results

Sub-Matrix: SEDIMENT (Matrix: SOIL)				Client sample ID	U3-R1	U3-R2	LW8	U4	LW5
				Client sampling date / time	15-Oct-2019 00:00	15-Oct-2019 00:00	15-Oct-2019 00:00	15-Oct-2019 00:00	19-Oct-2019 00:00
Compound	CAS Number	LOR	Unit		EB1927891-001	EB1927891-002	EB1927891-003	EB1927891-004	EB1927891-005
					Result	Result	Result	Result	Result
EA055: Moisture Content (Dried @ 105-110°C)									
Moisture Content	----	1.0	%		3.5	2.9	44.7	2.6	49.4
EG005(ED093)T: Total Metals by ICP-AES									
Aluminium	7429-90-5	50	mg/kg		12400	13600	11300	11100	11400
Arsenic	7440-38-2	5	mg/kg		<5	<5	<5	<5	<5
Barium	7440-39-3	10	mg/kg		480	580	380	280	320
Beryllium	7440-41-7	1	mg/kg		<1	1	<1	<1	<1
Boron	7440-42-8	50	mg/kg		<50	<50	<50	<50	<50
Cadmium	7440-43-9	1	mg/kg		<1	<1	<1	<1	<1
Chromium	7440-47-3	2	mg/kg		24	24	21	23	29
Cobalt	7440-48-4	2	mg/kg		18	19	19	18	11
Copper	7440-50-8	5	mg/kg		19	21	30	20	23
Iron	7439-89-6	50	mg/kg		18800	20900	41400	28200	19500
Lead	7439-92-1	5	mg/kg		18	20	20	20	11
Manganese	7439-96-5	5	mg/kg		1570	1880	1680	1100	598
Molybdenum	7439-98-7	2	mg/kg		<2	<2	<2	<2	<2
Nickel	7440-02-0	2	mg/kg		23	23	24	19	25
Selenium	7782-49-2	5	mg/kg		<5	<5	<5	<5	<5
Vanadium	7440-62-2	5	mg/kg		67	74	56	65	51
Zinc	7440-66-6	5	mg/kg		16	15	52	24	21
EG020T: Total Metals by ICP-MS									
Silver	7440-22-4	0.1	mg/kg		<0.1	<0.1	<0.1	<0.1	<0.1
Uranium	7440-61-1	0.1	mg/kg		0.4	0.4	0.8	0.6	0.4
EG035T: Total Recoverable Mercury by FIMS									
Mercury	7439-97-6	0.1	mg/kg		<0.1	<0.1	<0.1	<0.1	<0.1
EP080/071: Total Petroleum Hydrocarbons									
C6 - C9 Fraction	----	10	mg/kg		<10	<10	<10	<10	<10
C10 - C14 Fraction	----	50	mg/kg		<50	<50	<50	<50	<50
C15 - C28 Fraction	----	100	mg/kg		<100	<100	<100	<100	<100
C29 - C36 Fraction	----	100	mg/kg		<100	<100	<100	<100	<100
^ C10 - C36 Fraction (sum)	----	50	mg/kg		<50	<50	<50	<50	<50
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions									
C6 - C10 Fraction	C6_C10	10	mg/kg		<10	<10	<10	<10	<10
^ C6 - C10 Fraction minus BTEX (F1)	C6_C10-BTEX	10	mg/kg		<10	<10	<10	<10	<10

Analytical Results

Sub-Matrix: SEDIMENT (Matrix: SOIL)				Client sample ID	U3-R1	U3-R2	LW8	U4	LW5
				Client sampling date / time	15-Oct-2019 00:00	15-Oct-2019 00:00	15-Oct-2019 00:00	15-Oct-2019 00:00	19-Oct-2019 00:00
Compound	CAS Number	LOR	Unit		EB1927891-001	EB1927891-002	EB1927891-003	EB1927891-004	EB1927891-005
					Result	Result	Result	Result	Result
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions - Continued									
>C10 - C16 Fraction	----	50	mg/kg		<50	<50	<50	<50	<50
>C16 - C34 Fraction	----	100	mg/kg		<100	<100	<100	<100	<100
>C34 - C40 Fraction	----	100	mg/kg		<100	<100	<100	<100	<100
^ **>C10 - C40 Fraction (sum)**	----	50	mg/kg		<50	<50	<50	<50	<50
^ **>C10 - C16 Fraction minus Naphthalene (F2)**	----	50	mg/kg		<50	<50	<50	<50	<50
EP080: BTEXN									
Benzene	71-43-2	0.2	mg/kg		<0.2	<0.2	<0.2	<0.2	<0.2
Toluene	108-88-3	0.5	mg/kg		<0.5	<0.5	<0.5	<0.5	<0.5
Ethylbenzene	100-41-4	0.5	mg/kg		<0.5	<0.5	<0.5	<0.5	<0.5
meta- & para-Xylene	108-38-3 106-42-3	0.5	mg/kg		<0.5	<0.5	<0.5	<0.5	<0.5
ortho-Xylene	95-47-6	0.5	mg/kg		<0.5	<0.5	<0.5	<0.5	<0.5
^ **Sum of BTEX**	----	0.2	mg/kg		<0.2	<0.2	<0.2	<0.2	<0.2
^ **Total Xylenes**	----	0.5	mg/kg		<0.5	<0.5	<0.5	<0.5	<0.5
Naphthalene	91-20-3	1	mg/kg		<1	<1	<1	<1	<1
EP080S: TPH(V)/BTEX Surrogates									
1.2-Dichloroethane-D4	17060-07-0	0.2	%		**101**	**103**	**92.2**	**105**	**82.3**
Toluene-D8	2037-26-5	0.2	%		**99.9**	**100**	**103**	**103**	**76.7**
4-Bromofluorobenzene	460-00-4	0.2	%		**111**	**111**	**103**	**113**	**87.6**

Analytical Results

Sub-Matrix: SEDIMENT (Matrix: SOIL)				Client sample ID	U1	I1	I3	I2a	PW1
				Client sampling date / time	17-Oct-2019 00:00	17-Oct-2019 00:00	18-Oct-2019 00:00	18-Oct-2019 00:00	18-Oct-2019 00:00
Compound	CAS Number	LOR	Unit		EB1927891-006	EB1927891-007	EB1927891-008	EB1927891-009	EB1927891-010
					Result	Result	Result	Result	Result
EA055: Moisture Content (Dried @ 105-110°C)									
Moisture Content	----	1.0	%		1.2	<1.0	2.7	<1.0	2.5
EG005(ED093)T: Total Metals by ICP-AES									
Aluminium	7429-90-5	50	mg/kg		2610	1600	580	540	9460
Arsenic	7440-38-2	5	mg/kg		<5	<5	<5	<5	<5
Barium	7440-39-3	10	mg/kg		50	30	10	<10	180
Beryllium	7440-41-7	1	mg/kg		<1	<1	<1	<1	<1
Boron	7440-42-8	50	mg/kg		<50	<50	<50	<50	<50
Cadmium	7440-43-9	1	mg/kg		<1	<1	<1	<1	<1
Chromium	7440-47-3	2	mg/kg		9	20	4	5	20
Cobalt	7440-48-4	2	mg/kg		4	3	<2	<2	8
Copper	7440-50-8	5	mg/kg		<5	<5	<5	<5	21
Iron	7439-89-6	50	mg/kg		9960	8490	3210	3490	17300
Lead	7439-92-1	5	mg/kg		6	<5	<5	<5	12
Manganese	7439-96-5	5	mg/kg		94	100	35	35	228
Molybdenum	7439-98-7	2	mg/kg		<2	<2	<2	<2	<2
Nickel	7440-02-0	2	mg/kg		7	7	2	3	22
Selenium	7782-49-2	5	mg/kg		<5	<5	<5	<5	<5
Vanadium	7440-62-2	5	mg/kg		17	14	6	6	39
Zinc	7440-66-6	5	mg/kg		8	8	<5	<5	41
EG020T: Total Metals by ICP-MS									
Silver	7440-22-4	0.1	mg/kg		<0.1	<0.1	<0.1	<0.1	<0.1
Uranium	7440-61-1	0.1	mg/kg		0.2	0.1	<0.1	<0.1	0.7
EG035T: Total Recoverable Mercury by FIMS									
Mercury	7439-97-6	0.1	mg/kg		<0.1	<0.1	<0.1	<0.1	<0.1
EP080/071: Total Petroleum Hydrocarbons									
C6 - C9 Fraction	----	10	mg/kg		<10	<10	<10	<10	<10
C10 - C14 Fraction	----	50	mg/kg		<50	<50	<50	<50	250
C15 - C28 Fraction	----	100	mg/kg		<100	<100	<100	<100	860
C29 - C36 Fraction	----	100	mg/kg		<100	<100	<100	<100	530
^ C10 - C36 Fraction (sum)	----	50	mg/kg		<50	<50	<50	<50	1640
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions									
C6 - C10 Fraction	C6_C10	10	mg/kg		<10	<10	<10	<10	<10
^ C6 - C10 Fraction minus BTEX (F1)	C6_C10-BTEX	10	mg/kg		<10	<10	<10	<10	<10

Analytical Results

Sub-Matrix: SEDIMENT (Matrix: SOIL)				Client sample ID	U1	I1	I3	I2a	PW1
				Client sampling date / time	17-Oct-2019 00:00	17-Oct-2019 00:00	18-Oct-2019 00:00	18-Oct-2019 00:00	18-Oct-2019 00:00
Compound	CAS Number	LOR	Unit		EB1927891-006	EB1927891-007	EB1927891-008	EB1927891-009	EB1927891-010
					Result	Result	Result	Result	Result
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions - Continued									
>C10 - C16 Fraction	----	50	mg/kg		<50	<50	<50	<50	**260**
>C16 - C34 Fraction	----	100	mg/kg		<100	<100	<100	<100	**1160**
>C34 - C40 Fraction	----	100	mg/kg		<100	<100	<100	<100	**180**
^ **>C10 - C40 Fraction (sum)**	----	50	mg/kg		<50	<50	<50	<50	**1600**
^ **>C10 - C16 Fraction minus Naphthalene (F2)**	----	50	mg/kg		<50	<50	<50	<50	**260**
EP080: BTEXN									
Benzene	71-43-2	0.2	mg/kg		<0.2	<0.2	<0.2	<0.2	<0.2
Toluene	108-88-3	0.5	mg/kg		<0.5	<0.5	<0.5	<0.5	<0.5
Ethylbenzene	100-41-4	0.5	mg/kg		<0.5	<0.5	<0.5	<0.5	<0.5
meta- & para-Xylene	108-38-3 106-42-3	0.5	mg/kg		<0.5	<0.5	<0.5	<0.5	<0.5
ortho-Xylene	95-47-6	0.5	mg/kg		<0.5	<0.5	<0.5	<0.5	<0.5
^ **Sum of BTEX**	----	0.2	mg/kg		<0.2	<0.2	<0.2	<0.2	<0.2
^ **Total Xylenes**	----	0.5	mg/kg		<0.5	<0.5	<0.5	<0.5	<0.5
Naphthalene	91-20-3	1	mg/kg		<1	<1	<1	<1	<1
EP080S: TPH(V)/BTEX Surrogates									
1.2-Dichloroethane-D4	17060-07-0	0.2	%		**108**	**101**	**111**	**111**	**108**
Toluene-D8	2037-26-5	0.2	%		**98.3**	**95.2**	**87.6**	**98.2**	**100**
4-Bromofluorobenzene	460-00-4	0.2	%		**105**	**104**	**104**	**111**	**106**

Analytical Results

Sub-Matrix: SEDIMENT (Matrix: SOIL)				Client sample ID	PW4	U2	RCT4	RC1	LW9
				Client sampling date / time	20-Oct-2019 00:00	20-Oct-2019 00:00	17-Oct-2019 00:00	16-Oct-2019 00:00	16-Oct-2019 00:00
Compound	CAS Number	LOR	Unit		EB1927891-012	EB1927891-013	EB1927891-014	EB1927891-015	EB1927891-016
					Result	Result	Result	Result	Result
EA055: Moisture Content (Dried @ 105-110°C)									
Moisture Content	----	1.0	%		5.2	1.4	2.2	<1.0	51.0
EG005(ED093)T: Total Metals by ICP-AES									
Aluminium	7429-90-5	50	mg/kg		8020	11000	9780	1350	9820
Arsenic	7440-38-2	5	mg/kg		<5	<5	<5	<5	<5
Barium	7440-39-3	10	mg/kg		170	330	330	50	270
Beryllium	7440-41-7	1	mg/kg		1	<1	<1	<1	<1
Boron	7440-42-8	50	mg/kg		<50	<50	<50	<50	<50
Cadmium	7440-43-9	1	mg/kg		<1	<1	<1	<1	<1
Chromium	7440-47-3	2	mg/kg		21	11	31	10	28
Cobalt	7440-48-4	2	mg/kg		11	13	15	4	11
Copper	7440-50-8	5	mg/kg		23	41	20	<5	23
Iron	7439-89-6	50	mg/kg		20000	19700	23900	6680	15200
Lead	7439-92-1	5	mg/kg		15	16	13	<5	15
Manganese	7439-96-5	5	mg/kg		238	990	926	219	440
Molybdenum	7439-98-7	2	mg/kg		<2	<2	<2	<2	<2
Nickel	7440-02-0	2	mg/kg		20	12	29	5	24
Selenium	7782-49-2	5	mg/kg		<5	<5	<5	<5	<5
Vanadium	7440-62-2	5	mg/kg		44	51	64	15	67
Zinc	7440-66-6	5	mg/kg		37	26	18	<5	25
EG020T: Total Metals by ICP-MS									
Silver	7440-22-4	0.1	mg/kg		<0.1	<0.1	<0.1	<0.1	<0.1
Uranium	7440-61-1	0.1	mg/kg		0.8	0.4	0.3	0.1	0.6
EG035T: Total Recoverable Mercury by FIMS									
Mercury	7439-97-6	0.1	mg/kg		<0.1	<0.1	<0.1	<0.1	<0.1
EP080/071: Total Petroleum Hydrocarbons									
C6 - C9 Fraction	----	10	mg/kg		<10	----	<10	<10	<10
C10 - C14 Fraction	----	50	mg/kg		<50	----	<50	<50	<50
C15 - C28 Fraction	----	100	mg/kg		<100	----	<100	<100	<100
C29 - C36 Fraction	----	100	mg/kg		<100	----	<100	<100	200
^ C10 - C36 Fraction (sum)	----	50	mg/kg		<50	----	<50	<50	200
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions									
C6 - C10 Fraction	C6_C10	10	mg/kg		<10	----	<10	<10	<10
^ C6 - C10 Fraction minus BTEX (F1)	C6_C10-BTEX	10	mg/kg		<10	----	<10	<10	<10

Analytical Results

Sub-Matrix: SEDIMENT (Matrix: SOIL)				Client sample ID	PW4	U2	RCT4	RC1	LW9
				Client sampling date / time	20-Oct-2019 00:00	20-Oct-2019 00:00	17-Oct-2019 00:00	16-Oct-2019 00:00	16-Oct-2019 00:00
Compound	CAS Number	LOR	Unit		EB1927891-012	EB1927891-013	EB1927891-014	EB1927891-015	EB1927891-016
					Result	Result	Result	Result	Result
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions - Continued									
>C10 - C16 Fraction	----	50	mg/kg		<50	----	<50	<50	<50
>C16 - C34 Fraction	----	100	mg/kg		**100**	----	<100	<100	**220**
>C34 - C40 Fraction	----	100	mg/kg		<100	----	<100	<100	<100
^ >C10 - C40 Fraction (sum)	----	50	mg/kg		**100**	----	<50	<50	**220**
^ >C10 - C16 Fraction minus Naphthalene (F2)	----	50	mg/kg		<50	----	<50	<50	<50
EP080: BTEXN									
Benzene	71-43-2	0.2	mg/kg		<0.2	----	<0.2	<0.2	<0.2
Toluene	108-88-3	0.5	mg/kg		<0.5	----	<0.5	<0.5	<0.5
Ethylbenzene	100-41-4	0.5	mg/kg		<0.5	----	<0.5	<0.5	<0.5
meta- & para-Xylene	108-38-3 106-42-3	0.5	mg/kg		<0.5	----	<0.5	<0.5	<0.5
ortho-Xylene	95-47-6	0.5	mg/kg		<0.5	----	<0.5	<0.5	<0.5
^ Sum of BTEX	----	0.2	mg/kg		<0.2	----	<0.2	<0.2	<0.2
^ Total Xylenes	----	0.5	mg/kg		<0.5	----	<0.5	<0.5	<0.5
Naphthalene	91-20-3	1	mg/kg		<1	----	<1	<1	<1
EP080S: TPH(V)/BTEX Surrogates									
1.2-Dichloroethane-D4	17060-07-0	0.2	%		**111**	----	**122**	**114**	**90.4**
Toluene-D8	2037-26-5	0.2	%		**106**	----	**98.3**	**97.2**	**83.8**
4-Bromofluorobenzene	460-00-4	0.2	%		**115**	----	**112**	**108**	**91.7**

Analytical Results

Sub-Matrix: SEDIMENT (Matrix: SOIL)				Client sample ID	I1a	----	----	----	----
				Client sampling date / time	20-Oct-2019 00:00	----	----	----	----
Compound	CAS Number	LOR	Unit		EB1927891-017	--------	--------	--------	--------
					Result	----	----	----	----
EA055: Moisture Content (Dried @ 105-110°C)									
Moisture Content	----	1.0	%		45.4	----	----	----	----
EG005(ED093)T: Total Metals by ICP-AES									
Aluminium	7429-90-5	50	mg/kg		6560	----	----	----	----
Arsenic	7440-38-2	5	mg/kg		<5	----	----	----	----
Barium	7440-39-3	10	mg/kg		140	----	----	----	----
Beryllium	7440-41-7	1	mg/kg		<1	----	----	----	----
Boron	7440-42-8	50	mg/kg		<50	----	----	----	----
Cadmium	7440-43-9	1	mg/kg		<1	----	----	----	----
Chromium	7440-47-3	2	mg/kg		18	----	----	----	----
Cobalt	7440-48-4	2	mg/kg		11	----	----	----	----
Copper	7440-50-8	5	mg/kg		16	----	----	----	----
Iron	7439-89-6	50	mg/kg		22400	----	----	----	----
Lead	7439-92-1	5	mg/kg		13	----	----	----	----
Manganese	7439-96-5	5	mg/kg		348	----	----	----	----
Molybdenum	7439-98-7	2	mg/kg		<2	----	----	----	----
Nickel	7440-02-0	2	mg/kg		21	----	----	----	----
Selenium	7782-49-2	5	mg/kg		<5	----	----	----	----
Vanadium	7440-62-2	5	mg/kg		32	----	----	----	----
Zinc	7440-66-6	5	mg/kg		33	----	----	----	----
EG020T: Total Metals by ICP-MS									
Silver	7440-22-4	0.1	mg/kg		<0.1	----	----	----	----
Uranium	7440-61-1	0.1	mg/kg		0.5	----	----	----	----
EG035T: Total Recoverable Mercury by FIMS									
Mercury	7439-97-6	0.1	mg/kg		<0.1	----	----	----	----
EP080/071: Total Petroleum Hydrocarbons									
C6 - C9 Fraction	----	10	mg/kg		<10	----	----	----	----
C10 - C14 Fraction	----	50	mg/kg		50	----	----	----	----
C15 - C28 Fraction	----	100	mg/kg		160	----	----	----	----
C29 - C36 Fraction	----	100	mg/kg		200	----	----	----	----
^ C10 - C36 Fraction (sum)	----	50	mg/kg		410	----	----	----	----
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions									
C6 - C10 Fraction	C6_C10	10	mg/kg		<10	----	----	----	----
^ C6 - C10 Fraction minus BTEX (F1)	C6_C10-BTEX	10	mg/kg		<10	----	----	----	----

Analytical Results

Sub-Matrix: SEDIMENT (Matrix: SOIL)				Client sample ID	I1a	----	----	----	----
				Client sampling date / time	20-Oct-2019 00:00	----	----	----	----
Compound	CAS Number	LOR	Unit		EB1927891-017	--------	--------	--------	--------
					Result	----	----	----	----
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions - Continued									
>C10 - C16 Fraction	----	50	mg/kg		**80**	----	----	----	----
>C16 - C34 Fraction	----	100	mg/kg		**270**	----	----	----	----
>C34 - C40 Fraction	----	100	mg/kg		**100**	----	----	----	----
^ **>C10 - C40 Fraction (sum)**	----	50	mg/kg		**450**	----	----	----	----
^ **>C10 - C16 Fraction minus Naphthalene (F2)**	----	50	mg/kg		**80**	----	----	----	----
EP080: BTEXN									
Benzene	71-43-2	0.2	mg/kg		<0.2	----	----	----	----
Toluene	108-88-3	0.5	mg/kg		<0.5	----	----	----	----
Ethylbenzene	100-41-4	0.5	mg/kg		<0.5	----	----	----	----
meta- & para-Xylene	108-38-3 106-42-3	0.5	mg/kg		<0.5	----	----	----	----
ortho-Xylene	95-47-6	0.5	mg/kg		<0.5	----	----	----	----
^ **Sum of BTEX**	----	0.2	mg/kg		<0.2	----	----	----	----
^ **Total Xylenes**	----	0.5	mg/kg		<0.5	----	----	----	----
Naphthalene	91-20-3	1	mg/kg		<1	----	----	----	----
EP080S: TPH(V)/BTEX Surrogates									
1.2-Dichloroethane-D4	17060-07-0	0.2	%		**88.4**	----	----	----	----
Toluene-D8	2037-26-5	0.2	%		**83.5**	----	----	----	----
4-Bromofluorobenzene	460-00-4	0.2	%		**91.9**	----	----	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	LW8	LW5-R1	LW5-R2	LW9	I1a-R1
				Client sampling date / time	15-Oct-2019 00:00	19-Oct-2019 00:00	19-Oct-2019 00:00	16-Oct-2019 00:00	20-Oct-2019 00:00
Compound	CAS Number	LOR	Unit		EB1927891-018	EB1927891-019	EB1927891-020	EB1927891-021	EB1927891-022
					Result	Result	Result	Result	Result
EA015: Total Dissolved Solids dried at 180 ± 5 °C									
Total Dissolved Solids @180°C	----	10	mg/L		425	207	206	166	401
EA025: Total Suspended Solids dried at 104 ± 2°C									
Suspended Solids (SS)	----	5	mg/L		17	26	28	6	51
EA065: Total Hardness as CaCO3									
Total Hardness as CaCO3	----	1	mg/L		140	60	60	78	189
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L		4	3	2	<1	2
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L		20	9	9	18	33
Magnesium	7439-95-4	1	mg/L		22	9	9	8	26
Sodium	7440-23-5	1	mg/L		89	46	46	14	66
Potassium	7440-09-7	1	mg/L		15	6	5	8	13
EG020F: Dissolved Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Arsenic	7440-38-2	0.001	mg/L		0.001	0.002	0.001	0.002	0.002
Cadmium	7440-43-9	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	7440-47-3	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L		0.002	0.002	0.002	<0.001	<0.001
Cobalt	7440-48-4	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Nickel	7440-02-0	0.001	mg/L		0.001	<0.001	<0.001	0.003	0.003
Lead	7439-92-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Selenium	7782-49-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	7440-66-6	0.005	mg/L		<0.005	<0.005	<0.005	<0.005	<0.005
Manganese	7439-96-5	0.001	mg/L		0.004	0.002	0.002	0.005	0.559
Molybdenum	7439-98-7	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Uranium	7440-61-1	0.001	mg/L		0.002	<0.001	<0.001	<0.001	<0.001
Vanadium	7440-62-2	0.01	mg/L		<0.01	0.01	0.01	<0.01	<0.01
Boron	7440-42-8	0.05	mg/L		0.27	0.16	0.17	0.07	0.13
Iron	7439-89-6	0.05	mg/L		<0.05	<0.05	<0.05	<0.05	<0.05
EG020T: Total Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L		0.94	2.33	1.37	0.15	0.53
Arsenic	7440-38-2	0.001	mg/L		0.001	0.002	0.002	0.002	0.002
Cadmium	7440-43-9	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	7440-47-3	0.001	mg/L		<0.001	0.004	<0.001	<0.001	<0.001

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	LW8	LW5-R1	LW5-R2	LW9	I1a-R1
				Client sampling date / time	15-Oct-2019 00:00	19-Oct-2019 00:00	19-Oct-2019 00:00	16-Oct-2019 00:00	20-Oct-2019 00:00
Compound	CAS Number	LOR	Unit		EB1927891-018	EB1927891-019	EB1927891-020	EB1927891-021	EB1927891-022
					Result	Result	Result	Result	Result
EG020T: Total Metals by ICP-MS - Continued									
Copper	7440-50-8	0.001	mg/L		**0.002**	**0.005**	**0.003**	<0.001	**0.001**
Cobalt	7440-48-4	0.001	mg/L		<0.001	**0.001**	<0.001	<0.001	**0.002**
Nickel	7440-02-0	0.001	mg/L		**0.002**	**0.004**	**0.002**	**0.003**	**0.004**
Lead	7439-92-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Selenium	7782-49-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	7440-66-6	0.005	mg/L		<0.005	<0.005	<0.005	<0.005	<0.005
Manganese	7439-96-5	0.001	mg/L		**0.117**	**0.082**	**0.040**	**0.188**	**0.893**
Molybdenum	7439-98-7	0.001	mg/L		<0.001	<0.001	<0.001	**0.001**	<0.001
Uranium	7440-61-1	0.001	mg/L		**0.002**	<0.001	<0.001	<0.001	<0.001
Vanadium	7440-62-2	0.01	mg/L		<0.01	**0.02**	**0.01**	<0.01	<0.01
Boron	7440-42-8	0.05	mg/L		**0.36**	**0.18**	**0.20**	**0.08**	**0.14**
Iron	7439-89-6	0.05	mg/L		**0.95**	**1.74**	**0.94**	**0.26**	**2.01**
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EG035T: Total Recoverable Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EG094F: Dissolved Metals in Fresh Water by ORC-ICPMS									
Silver	7440-22-4	0.01	µg/L		<0.01	<0.01	<0.01	<0.01	<0.01
EG094T: Total metals in Fresh water by ORC-ICPMS									
Silver	7440-22-4	0.01	µg/L		<0.01	<0.01	<0.01	<0.01	<0.01
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L		**0.6**	**0.9**	**0.9**	**0.2**	**0.3**
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L		**0.04**	**0.03**	**0.12**	<0.01	**0.04**
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L		<0.01	**0.15**	<0.01	<0.01	<0.01
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		<0.01	**0.15**	<0.01	<0.01	<0.01
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L		**2.1**	**0.8**	**0.8**	**0.9**	**2.6**
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	LW8	LW5-R1	LW5-R2	LW9	I1a-R1
				Client sampling date / time	15-Oct-2019 00:00	19-Oct-2019 00:00	19-Oct-2019 00:00	16-Oct-2019 00:00	20-Oct-2019 00:00
Compound	CAS Number	LOR	Unit		EB1927891-018	EB1927891-019	EB1927891-020	EB1927891-021	EB1927891-022
					Result	Result	Result	Result	Result
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser - Continued									
^ Total Nitrogen as N	----	0.1	mg/L		2.1	1.0	0.8	0.9	2.6
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		0.06	0.02	0.02	0.03	0.15
EK071G: Reactive Phosphorus as P by discrete analyser									
Reactive Phosphorus as P	14265-44-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
EP080/071: Total Petroleum Hydrocarbons									
C6 - C9 Fraction	----	20	µg/L		<20	<20	<20	<20	<20
C10 - C14 Fraction	----	50	µg/L		<50	<50	<50	<50	<50
C15 - C28 Fraction	----	100	µg/L		<100	<100	<100	<100	200
C29 - C36 Fraction	----	50	µg/L		<50	<50	<50	<50	<50
^ C10 - C36 Fraction (sum)	----	50	µg/L		<50	<50	<50	<50	200
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions									
C6 - C10 Fraction	C6_C10	20	µg/L		<20	<20	<20	<20	<20
^ C6 - C10 Fraction minus BTEX (F1)	C6_C10-BTEX	20	µg/L		<20	<20	<20	<20	<20
>C10 - C16 Fraction	----	100	µg/L		<100	<100	<100	<100	<100
>C16 - C34 Fraction	----	100	µg/L		<100	<100	<100	<100	220
>C34 - C40 Fraction	----	100	µg/L		<100	<100	<100	<100	<100
^ >C10 - C40 Fraction (sum)	----	100	µg/L		<100	<100	<100	<100	220
^ >C10 - C16 Fraction minus Naphthalene (F2)	----	100	µg/L		<100	<100	<100	<100	<100
EP080: BTEXN									
Benzene	71-43-2	1	µg/L		<1	<1	<1	<1	<1
Toluene	108-88-3	2	µg/L		<2	<2	<2	<2	<2
Ethylbenzene	100-41-4	2	µg/L		<2	<2	<2	<2	<2
meta- & para-Xylene	108-38-3 106-42-3	2	µg/L		<2	<2	<2	<2	<2
ortho-Xylene	95-47-6	2	µg/L		<2	<2	<2	<2	<2
^ Total Xylenes	----	2	µg/L		<2	<2	<2	<2	<2
^ Sum of BTEX	----	1	µg/L		<1	<1	<1	<1	<1
Naphthalene	91-20-3	5	µg/L		<5	<5	<5	<5	<5
EP080S: TPH(V)/BTEX Surrogates									
1.2-Dichloroethane-D4	17060-07-0	2	%		98.4	100	102	101	98.6
Toluene-D8	2037-26-5	2	%		99.0	98.1	100.0	101	100
4-Bromofluorobenzene	460-00-4	2	%		97.4	98.1	98.8	100.0	96.6

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	I1a-R2	----	----	----	----
				Client sampling date / time	20-Oct-2019 00:00	----	----	----	----
Compound	CAS Number	LOR	Unit		EB1927891-023	--------	--------	--------	--------
					Result	----	----	----	----
EA015: Total Dissolved Solids dried at 180 ± 5 °C									
Total Dissolved Solids @180°C	----	10	mg/L		<10	----	----	----	----
EA025: Total Suspended Solids dried at 104 ± 2°C									
Suspended Solids (SS)	----	5	mg/L		<5	----	----	----	----
EA065: Total Hardness as CaCO3									
Total Hardness as CaCO3	----	1	mg/L		<1	----	----	----	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L		<1	----	----	----	----
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L		<1	----	----	----	----
Magnesium	7439-95-4	1	mg/L		<1	----	----	----	----
Sodium	7440-23-5	1	mg/L		<1	----	----	----	----
Potassium	7440-09-7	1	mg/L		<1	----	----	----	----
EG020F: Dissolved Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L		<0.01	----	----	----	----
Arsenic	7440-38-2	0.001	mg/L		<0.001	----	----	----	----
Cadmium	7440-43-9	0.0001	mg/L		<0.0001	----	----	----	----
Chromium	7440-47-3	0.001	mg/L		<0.001	----	----	----	----
Copper	7440-50-8	0.001	mg/L		<0.001	----	----	----	----
Cobalt	7440-48-4	0.001	mg/L		<0.001	----	----	----	----
Nickel	7440-02-0	0.001	mg/L		<0.001	----	----	----	----
Lead	7439-92-1	0.001	mg/L		<0.001	----	----	----	----
Selenium	7782-49-2	0.01	mg/L		<0.01	----	----	----	----
Zinc	7440-66-6	0.005	mg/L		<0.005	----	----	----	----
Manganese	7439-96-5	0.001	mg/L		<0.001	----	----	----	----
Molybdenum	7439-98-7	0.001	mg/L		<0.001	----	----	----	----
Uranium	7440-61-1	0.001	mg/L		<0.001	----	----	----	----
Vanadium	7440-62-2	0.01	mg/L		<0.01	----	----	----	----
Boron	7440-42-8	0.05	mg/L		<0.05	----	----	----	----
Iron	7439-89-6	0.05	mg/L		<0.05	----	----	----	----
EG020T: Total Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L		<0.01	----	----	----	----
Arsenic	7440-38-2	0.001	mg/L		<0.001	----	----	----	----
Cadmium	7440-43-9	0.0001	mg/L		<0.0001	----	----	----	----
Chromium	7440-47-3	0.001	mg/L		<0.001	----	----	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	I1a-R2	----	----	----	----
				Client sampling date / time	20-Oct-2019 00:00	----	----	----	----
Compound	CAS Number	LOR	Unit		EB1927891-023	--------	--------	--------	--------
					Result	----	----	----	----
EG020T: Total Metals by ICP-MS - Continued									
Copper	7440-50-8	0.001	mg/L		<0.001	----	----	----	----
Cobalt	7440-48-4	0.001	mg/L		<0.001	----	----	----	----
Nickel	7440-02-0	0.001	mg/L		<0.001	----	----	----	----
Lead	7439-92-1	0.001	mg/L		<0.001	----	----	----	----
Selenium	7782-49-2	0.01	mg/L		<0.01	----	----	----	----
Zinc	7440-66-6	0.005	mg/L		<0.005	----	----	----	----
Manganese	7439-96-5	0.001	mg/L		<0.001	----	----	----	----
Molybdenum	7439-98-7	0.001	mg/L		<0.001	----	----	----	----
Uranium	7440-61-1	0.001	mg/L		<0.001	----	----	----	----
Vanadium	7440-62-2	0.01	mg/L		<0.01	----	----	----	----
Boron	7440-42-8	0.05	mg/L		<0.05	----	----	----	----
Iron	7439-89-6	0.05	mg/L		<0.05	----	----	----	----
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	----	----	----	----
EG035T: Total Recoverable Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	----	----	----	----
EG094F: Dissolved Metals in Fresh Water by ORC-ICPMS									
Silver	7440-22-4	0.01	µg/L		<0.01	----	----	----	----
EG094T: Total metals in Fresh water by ORC-ICPMS									
Silver	7440-22-4	0.01	µg/L		<0.01	----	----	----	----
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L		<0.1	----	----	----	----
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L		**0.04**	----	----	----	----
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L		<0.01	----	----	----	----
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L		<0.01	----	----	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		<0.01	----	----	----	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L		<0.1	----	----	----	----
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	I1a-R2	----	----	----	----
				Client sampling date / time	20-Oct-2019 00:00	----	----	----	----
Compound	CAS Number	LOR	Unit		EB1927891-023	--------	--------	--------	--------
					Result	----	----	----	----
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser - Continued									
^ Total Nitrogen as N	----	0.1	mg/L		<0.1	----	----	----	----
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		<0.01	----	----	----	----
EK071G: Reactive Phosphorus as P by discrete analyser									
Reactive Phosphorus as P	14265-44-2	0.01	mg/L		<0.01	----	----	----	----
EP080/071: Total Petroleum Hydrocarbons									
C6 - C9 Fraction	----	20	µg/L		<20	----	----	----	----
C10 - C14 Fraction	----	50	µg/L		<50	----	----	----	----
C15 - C28 Fraction	----	100	µg/L		<100	----	----	----	----
C29 - C36 Fraction	----	50	µg/L		<50	----	----	----	----
^ C10 - C36 Fraction (sum)	----	50	µg/L		<50	----	----	----	----
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions									
C6 - C10 Fraction	C6_C10	20	µg/L		<20	----	----	----	----
^ C6 - C10 Fraction minus BTEX (F1)	C6_C10-BTEX	20	µg/L		<20	----	----	----	----
>C10 - C16 Fraction	----	100	µg/L		<100	----	----	----	----
>C16 - C34 Fraction	----	100	µg/L		<100	----	----	----	----
>C34 - C40 Fraction	----	100	µg/L		<100	----	----	----	----
^ >C10 - C40 Fraction (sum)	----	100	µg/L		<100	----	----	----	----
^ >C10 - C16 Fraction minus Naphthalene (F2)	----	100	µg/L		<100	----	----	----	----
EP080: BTEXN									
Benzene	71-43-2	1	µg/L		<1	----	----	----	----
Toluene	108-88-3	2	µg/L		<2	----	----	----	----
Ethylbenzene	100-41-4	2	µg/L		<2	----	----	----	----
meta- & para-Xylene	108-38-3 106-42-3	2	µg/L		<2	----	----	----	----
ortho-Xylene	95-47-6	2	µg/L		<2	----	----	----	----
^ Total Xylenes	----	2	µg/L		<2	----	----	----	----
^ Sum of BTEX	----	1	µg/L		<1	----	----	----	----
Naphthalene	91-20-3	5	µg/L		<5	----	----	----	----
EP080S: TPH(V)/BTEX Surrogates									
1.2-Dichloroethane-D4	17060-07-0	2	%		**102**	----	----	----	----
Toluene-D8	2037-26-5	2	%		**97.8**	----	----	----	----
4-Bromofluorobenzene	460-00-4	2	%		**95.4**	----	----	----	----

Surrogate Control Limits

Sub-Matrix: **SEDIMENT**

Compound	CAS Number	Recovery Limits (%) Low	High
EP080S: TPH(V)/BTEX Surrogates			
1.2-Dichloroethane-D4	17060-07-0	53	134
Toluene-D8	2037-26-5	60	131
4-Bromofluorobenzene	460-00-4	59	127

Sub-Matrix: **WATER**

Compound	CAS Number	Recovery Limits (%) Low	High
EP080S: TPH(V)/BTEX Surrogates			
1.2-Dichloroethane-D4	17060-07-0	66	138
Toluene-D8	2037-26-5	79	120
4-Bromofluorobenzene	460-00-4	74	118

Appendix C Aquatic Habitat Assessment Tables

Table 9.1 Aquatic habitat descriptions from each site during the field surveys; highlighted water quality cells indicate values that are outside of the relevant WQOs

<table>
<tr><th colspan="2">Site: CK1</th><th>Location: Upstream of MLAs; Upstream of Project area</th><th colspan="3">Stream Order: 5</th><th colspan="3">Waterway: Cherwell Creek</th></tr>
<tr><td colspan="2">Upstream: May 2019
  </td><td>Downstream: May 2019
  </td><td colspan="3">Upstream: October 2019
  </td><td colspan="3">Downstream: October 2019
  </td></tr>
<tr><td colspan="2">Aquatic Ecosystem Value: Moderate</td><td>MNES/MSES: None present or likely to occur</td><td colspan="3">Dry season refuge: No</td><td colspan="3">Connectivity: Good, during periods of flow</td></tr>
<tr><td colspan="2">In-stream condition: Fair
Key potential habitat features included:
• small amounts of small and large woody debris and detritus
• a limited range of sediment grain sizes (predominately sand with some silt/clay), and
• trailing and overhanging bank vegetation.
The site was dry during both the May and October surveys.</td><td>Riparian condition: Fair
There was a band of riparian vegetation around the perimeter of the waterway (approximately 10m on both banks), however the extent of the surrounding vegetation had been reduced by land clearing for a fence line, access track and grazing. Vegetation consisted of mature grasses, shrubs and trees (predominantly Eucalyptus and Casuarina). Banks were between 3 m and 6 m high, and gently sloping with some erosion. There were some exotic riparian species present at the site.</td><td colspan="3">External Impacts: Moderate
External impacts at the site were mostly associated with the surrounding land-use and included:
• reduced riparian vegetation as a result of land clearing for a fence line, access track and grazing, and
• evidence of cattle access.</td><td colspan="3">Water Quality:
<table><tr><th>Survey:</th><th>May ‘19</th><th>Oct ‘19</th></tr><tr><td>Condition:</td><td>Dry</td><td>Dry</td></tr><tr><td>Temp (ºC):</td><td>—</td><td>—</td></tr><tr><td>EC (µS/cm):</td><td>—</td><td>—</td></tr><tr><td>DO (% sat):</td><td>—</td><td>—</td></tr><tr><td>pH (pH units):</td><td>—</td><td>—</td></tr><tr><td>Turbidity (NTU):</td><td>—</td><td>—</td></tr></table></td></tr>
</table>

<table>
<tr><th colspan="2">Site: I1</th><th>Location: Upstream of MLAs; Upstream of Project area</th><th colspan="2">Stream Order: 6</th><th colspan="2">Waterway: Isaac River</th></tr>
<tr><td colspan="2">Upstream: May 2019
  </td><td>Downstream: May 2019
  </td><td colspan="2">Upstream: October 2019
  </td><td colspan="2">Downstream: October 2019
  </td></tr>
<tr><td colspan="2">Aquatic Ecosystem Value: Moderate</td><td>MNES/MSES: None present or likely to occur</td><td colspan="2">Dry season refuge: No</td><td colspan="2">Connectivity: Good, during periods of flow.</td></tr>
<tr><td colspan="2">In-stream condition: Fair
Key habitat features in May included:
• aquatic plants
• a variety of woody debris
• periphyton
• filamentous algae
• blanketing silt
• a range of sediment grain sizes (predominately sand with silt/clay, gravel, pebbles, cobble and boulders)
• shallow, sandy and rocky pools, and
• trailing and overhanging bank vegetation.
The site was near a road and rail crossing and consisted of isolated pools in May and was dry in October.</td><td>Riparian condition: Fair
The riparian zone was mostly continuous around the perimeter of the waterway, although the extent of the vegetation had been reduced by clearing near the road and rail crossings (vegetation zone was approx. 5 to 10 m wide near crossing). Vegetation consisted of grass, shrubs and trees (predominantly Eucalyptus and Casuarina). Banks were low (6 m – 8 m high) and gently sloping with minimal erosion. There some exotic terrestrial riparian species at the site, with an increased abundance surrounding the crossing.</td><td colspan="2">External Impacts: Moderate
External impacts at the site were mostly associated with the surrounding land-use and included:
• alteration of the habitat for the construction of the road and rail crossings, and
• reduced riparian vegetation as a result of land clearing.</td><td colspan="2">Water Quality:
<table><tr><th>Survey:</th><th>May ‘19</th><th>Oct ‘19</th></tr><tr><td>Condition:</td><td>Good</td><td>Dry</td></tr><tr><td>Temp (ºC):</td><td>23.1</td><td>—</td></tr><tr><td>EC (µS/cm):</td><td>320.3</td><td>—</td></tr><tr><td>DO (% sat):</td><td>114.2</td><td>—</td></tr><tr><td>pH (pH units):</td><td>8.29</td><td>—</td></tr><tr><td>Turbidity (NTU):</td><td>6.7</td><td>—</td></tr></table></td></tr>
</table>

<table>
<tr><th colspan="2">Site: U3</th><th>Location: Upstream of MLAs; Upstream of Project area; Eagle Downs</th><th colspan="3">Stream Order: 1</th><th>Waterway: Unnamed tributary of the Isaac River</th></tr>
<tr><td colspan="2">Upstream: May 2019
  </td><td>Downstream: May 2019
  </td><td colspan="3">Upstream: October 2019
  </td><td>Downstream: October 2019
  </td></tr>
<tr><td colspan="2">Aquatic Ecosystem Value: Low</td><td>MNES/MSES: None present or likely to occur</td><td colspan="3">Dry season refuge: No</td><td>Connectivity: Moderate, during periods of flow</td></tr>
<tr><td colspan="2">In-stream condition: Poor
Key potential habitat features included:
• a range of sediment grain sizes (predominately silt/clay with some cobble and boulders), and
• some trailing vegetation.
The site was dry during both the May and October surveys.</td><td>Riparian condition: Poor
The extent of the vegetation had been significantly reduced by land clearing (there was no remaining riparian vegetation). Vegetation consisted of grass. Banks were low (1 m high) and gently sloping with some erosion. There was a high abundance of exotic terrestrial riparian species.</td><td colspan="3">External Impacts: High
External impacts at the site were mostly associated with the surrounding land-use and included:
• reduced riparian vegetation as a result of extensive land clearing for grazing and an access track.</td><td colspan="3">Water Quality:
<table>
<tr><th>Survey:</th><th>May ‘19</th><th>Oct ‘19</th></tr>
<tr><td>Condition:</td><td>Dry</td><td>Dry</td></tr>
<tr><td>Temp (ºC):</td><td>—</td><td>—</td></tr>
<tr><td>EC (µS/cm):</td><td>—</td><td>—</td></tr>
<tr><td>DO (% sat):</td><td>—</td><td>—</td></tr>
<tr><td>pH (pH units):</td><td>—</td><td>—</td></tr>
<tr><td>Turbidity (NTU):</td><td>—</td><td>—</td></tr>
</table></td></tr>
</table>

<table>
<tr><td>Site: U3a</td><td>Location: Upstream of MLAs; Upstream of Project area</td><td>Stream Order: 1</td><td>Waterway: Unnamed tributary of the Isaac River</td></tr>
<tr><td>Left bank, downstream: October 2019
  </td><td>Right bank, downstream: October 2019
  </td><td>Upstream: October 2019
  </td><td>Downstream: October 2019
  </td></tr>
<tr><td>Aquatic Ecosystem Value: Low</td><td>MNES/MSES: None present or likely to occur</td><td>Dry season refuge: No</td><td>Connectivity: Poor</td></tr>
<tr><td>In-stream condition: Poor
Key potential habitat features included:
• a limited range of sediment grain sizes (including silt/clay and sand), and
• blanketing silt.
The site was dry and only surveyed in October.
The site would act only as a drainage channel conveying surface flows during high rainfall events.</td><td>Riparian condition: Poor
The riparian vegetation had been cleared and there was no riparian zone evident. Vegetation consisted of predominantly grasses. Banks of the drainage channel were low and poorly defined (0.1 m high).</td><td>External Impacts: High
External impacts at the site were mostly associated with the surrounding land-use and included reduced riparian vegetation as a result of land clearing for grazing.</td><td>Water Quality:
Survey: | May ‘19 | Oct ‘19
Condition: | Not surveyed | Dry
Temp (ºC): | — | —
EC (µS/cm): | — | —
DO (% sat): | — | —
pH (pH units): | — | —
Turbidity (NTU): | — | —</td></tr>
</table>

<table>
<tr><th colspan="2">Site: FD1</th><th>Location: Within MLA700049; Upstream of Project area</th><th>Stream Order: 1</th><th>Waterway: Unmapped farm dam on an unnamed tributary of the Isaac River</th></tr>
<tr><td colspan="2">Upstream: May 2019
  </td><td>Downstream: May 2019
  </td><td>Upstream: October 2019
  </td><td>Downstream: October 2019
  </td></tr>
<tr><td colspan="2">Aquatic Ecosystem Value: Low</td><td>MNES/MSES: None present or likely to occur</td><td>Dry season refuge: Yes, but poor quality</td><td>Connectivity: Limited except during high flows due to high dam walls</td></tr>
<tr><td colspan="2">In-stream condition: Poor
Key habitat features included:
• periphyton
• filamentous algae
• blanketing silt
• substrate anoxia
• a range of sediment grain sizes (predominately silt/clay with some sand and boulders), and
• shallow and deep pools.
The site consisted of a large farm dam which was surveyed during both May and October. The water level was lower in October than in May.</td><td>Riparian condition: Poor
The riparian zone had been reduced by land clearing and there was no remaining riparian vegetation except for some isolated mature trees in the broader area. Banks were low (0.5 m high) and gently sloping with some erosion. There was a moderate abundance of terrestrial weeds.</td><td>External Impacts: High
External impacts at the site were mostly associated with the surrounding land-use and included:
• alteration of habitat for the dam construction
• disturbance to bank stability and instream habitat from cattle access, and
• reduced riparian vegetation as a result of land clearing.</td><td>Water Quality:
<table>
<tr><th>Survey:</th><th>May ‘19</th><th>Oct ‘19</th></tr>
<tr><td>Condition:</td><td>Poor</td><td>Not sampled</td></tr>
<tr><td>Temp (ºC):</td><td>21.2</td><td>—</td></tr>
<tr><td>EC (µS/cm):</td><td>423.2</td><td>—</td></tr>
<tr><td>DO (% sat):</td><td>71.7</td><td>—</td></tr>
<tr><td>pH (pH units):</td><td>7.49</td><td>—</td></tr>
<tr><td>Turbidity (NTU):</td><td>489.6</td><td>—</td></tr>
</table></td></tr>
</table>

<table>
<tr><th>Site: RC1</th><th>Location: Adjacent to MLAs; Adjacent to Project area</th><th>Stream Order: 3</th><th>Waterway: Ripstone Creek</th></tr>
<tr><td>Upstream: May 2019
  </td><td>Downstream: May 2019
  </td><td>Upstream: October 2019
  </td><td>Downstream: October 2019
  </td></tr>
<tr><td>Aquatic Ecosystem Value: Moderate</td><td>MNES/MSES: None present or likely to occur</td><td>Dry season refuge: No</td><td>Connectivity: Moderate, but only during periods of high flow</td></tr>
<tr><td>In-stream condition: Fair
Key potential habitat features included:
• low abundance of aquatic plants
• a variety of woody debris
• good canopy cover
• some blanketing silt
• a limited range of sediment grain sizes (predominately sand with some silt/clay, gravel and pebbles), and
• trailing and overhanging bank vegetation.
The site was dry during both the May and October surveys.</td><td>Riparian condition: Good
The riparian zone consisted of continuous band of vegetation along the waterway, although the extent of the vegetation in the greater region had been reduced by land clearing (remaining riparian zone was approx. 10 - 15 m wide). Vegetation consisted of grasses, shrubs and trees (predominantly Casuarina and iron bark). Banks were approximately 4 m high and steep with some erosion. There was a moderate abundance of exotic riparian species present at the site.</td><td>External Impacts: Moderate
External impacts at the site were mostly associated with the surrounding land-use and included:
• disturbance to habitat from cattle access, and
• reduced riparian vegetation as a result of land clearing for grazing and access tracks.</td><td>Water Quality:
<table><tr><th>Survey:</th><th>May ‘19</th><th>Oct ‘19</th></tr><tr><td>Condition:</td><td>Dry</td><td>Dry</td></tr><tr><td>Temp (ºC):</td><td>—</td><td>—</td></tr><tr><td>EC (µS/cm):</td><td>—</td><td>—</td></tr><tr><td>DO (% sat):</td><td>—</td><td>—</td></tr><tr><td>pH (pH units):</td><td>—</td><td>—</td></tr><tr><td>Turbidity (NTU):</td><td>—</td><td>—</td></tr></table></td></tr>
</table>

<table>
<tr><th>Site: RCT1a</th><th>Location: Adjacent to MLAs; Adjacent to Project area</th><th>Stream Order: 2</th><th>Waterway: Unnamed tributary of Ripstone Creek</th></tr>
<tr><td>Left bank: October 2019
  </td><td>Waterway crossing: October 2019
  </td><td>Upstream: October 2019
  </td><td>Downstream: October 2019
  </td></tr>
<tr><td>Aquatic Ecosystem Value: Low</td><td>MNES/MSES: None present or likely to occur</td><td>Dry season refuge: No</td><td>Connectivity: Limited, would rarely hold water except for times of high flow</td></tr>
<tr><td>In-stream condition: Poor to fair
Key potential habitat features included:
• a range of woody debris including large woody debris
• canopy cover
• blanketing silt
• a range of sediment grain sizes (predominately silt/clay and sand with some gravel, pebbles, cobble and boulders), and
• trailing and overhanging bank vegetation.
The site was only surveyed in October and was dry.</td><td>Riparian condition: Fair
The riparian zone consisted of a thin strip of vegetation that had been reduced by land clearing (remaining vegetation zone was approx. 5 m wide on both banks). Vegetation consisted of predominately grasses with some shrubs and trees (Eucalyptus). Banks were low (1.5 m high) and gently sloping with some erosion. There was extensive exotic weed species present at the site.</td><td>External Impacts: Moderate
External impacts at the site were mostly associated with the surrounding land-use and included:
• reduced riparian vegetation as a result of land clearing for access tracks, rail crossing and grazing, and
• presence of culverts.</td><td>Water Quality:
<table><tr><th>Survey:</th><th>May ‘19</th><th>Oct ‘19</th></tr><tr><td>Condition:</td><td>Not surveyed</td><td>Dry</td></tr><tr><td>Temp (ºC):</td><td>—</td><td>—</td></tr><tr><td>EC (µS/cm):</td><td>—</td><td>—</td></tr><tr><td>DO (% sat):</td><td>—</td><td>—</td></tr><tr><td>pH (pH units):</td><td>—</td><td>—</td></tr><tr><td>Turbidity (NTU):</td><td>—</td><td>—</td></tr></table></td></tr>
</table>

<table>
<tr><th>Site: RCT1</th><th>Location: Adjacent to MLAs; Adjacent to Project area</th><th>Stream Order: 2</th><th>Waterway: Unnamed tributary of Ripstone Creek</th></tr>
<tr><td>Upstream: May 2019
  </td><td>Downstream: May 2019
  </td><td>Upstream: October 2019
  </td><td>Downstream: October 2019
  </td></tr>
<tr><td>Aquatic Ecosystem Value: Low</td><td>MNES/MSES: None present or likely to occur</td><td>Dry season refuge: No</td><td>Connectivity: Limited, would rarely hold water except for times of high flow</td></tr>
<tr><td>In-stream condition: Poor to fair
Key potential habitat features included:
• minimal aquatic plants
• a range of woody debris
• canopy cover
• blanketing silt
• a range of sediment grain sizes (predominately silt/clay and sand with some gravel, pebbles, cobble and boulders), and
• trailing and overhanging bank vegetation.
The site was dry in both the May and October surveys.</td><td>Riparian condition: Fair
The riparian zone consisted of a thin strip of vegetation that had been reduced by land clearing (remaining vegetation zone was approx. 5 m wide on the left bank and 3 m wide on the right bank). Vegetation consisted of predominately grasses with some shrubs and trees (Casuarina and Eucalyptus). Banks were low (3 m high) and gently sloping with some erosion. There was extensive exotic weed species present at the site.</td><td>External Impacts: Moderate
External impacts at the site were mostly associated with the surrounding land-use and included:
• reduced riparian vegetation as a result of land clearing for the highway crossing and grazing
• presence of culverts at the highway crossing, and
• rubbish and litter.</td><td>Water Quality:
<table><tr><th>Survey:</th><th>May ‘19</th><th>Oct ‘19</th></tr><tr><td>Condition:</td><td>Dry</td><td>Dry</td></tr><tr><td>Temp (ºC):</td><td>—</td><td>—</td></tr><tr><td>EC (µS/cm):</td><td>—</td><td>—</td></tr><tr><td>DO (% sat):</td><td>—</td><td>—</td></tr><tr><td>pH (pH units):</td><td>—</td><td>—</td></tr><tr><td>Turbidity (NTU):</td><td>—</td><td>—</td></tr></table></td></tr>
</table>

<table>
<tr><th>Site: RCT2</th><th>Location: Adjacent to MLAs; Adjacent to Project area</th><th>Stream Order: 2</th><th>Waterway : Unnamed tributary of Ripstone Creek</th></tr>
<tr><td>Upstream: May 2019
  </td><td>Downstream: May 2019
  </td><td>Upstream: October 2019
  </td><td>Downstream: October 2019
  </td></tr>
<tr><td>Aquatic Ecosystem Value: Low</td><td>MNES/MSES: None present or likely to occur</td><td>Dry season refuge: No</td><td>Connectivity: Limited, only during periods of high flow</td></tr>
<tr><td>In-stream condition: Poor
Key potential habitat features included:
• limited aquatic plants
• a variety of woody debris types
• minimal canopy cover
• a range of sediment grain sizes (predominantly sand with some silt/clay, gravel, pebbles, cobble and boulders)
• blanketing silt, and
• trailing and overhanging bank vegetation.
The site was dry during both the May and October surveys.</td><td>Riparian condition: Fair
Vegetation consisted of a continuous strip around the perimeter of the waterway, although the extent of the vegetation in the greater region had been reduced by land clearing (remaining riparian zone was approx. 5 m wide). Vegetation consisted of grasses, shrubs and trees (predominantly Eucalyptus and iron bark). Banks were low (3 m high) and steep with high levels of erosion in some sections. There was a moderate abundance of exotic riparian species present at the site.</td><td>External Impacts: Moderate
External impacts at the site were mostly associated with the surrounding land-use and included:
• reduced riparian vegetation and subsequent erosion as a result of land clearing.</td><td>Water Quality:
<table><tr><th>Survey:</th><th>May ‘19</th><th>Oct ‘19</th></tr><tr><td>Condition:</td><td>Dry</td><td>Dry</td></tr><tr><td>Temp (ºC):</td><td>—</td><td>—</td></tr><tr><td>EC (µS/cm):</td><td>—</td><td>—</td></tr><tr><td>DO (% sat):</td><td>—</td><td>—</td></tr><tr><td>pH (pH units):</td><td>—</td><td>—</td></tr><tr><td>Turbidity (NTU):</td><td>—</td><td>—</td></tr></table></td></tr>
</table>

<table>
<tr><th>Site: RCT3</th><th>Location: Adjacent to MLAs; Adjacent to Project area</th><th>Stream Order: 1</th><th>Waterway: Unnamed tributary of Ripstone Creek</th></tr>
<tr><td>Upstream: May 2019
  </td><td>Downstream: May 2019
  </td><td>Upstream: October 2019
  </td><td>Downstream: October 2019
  </td></tr>
<tr><td>Aquatic Ecosystem Value: Low</td><td>MNES/MSES: None present or likely to occur</td><td>Dry season refuge: No</td><td>Connectivity: Limited, during periods of high flow</td></tr>
<tr><td>In-stream condition: Poor
Key habitat features in May included:
• limited aquatic plants
• variety of woody debris
• periphyton
• blanketing silt
• a limited range of sediment grain sizes (including silt/clay and sand), and
• trailing bank vegetation.
The site consisted of small shallow pool in May and was dry during October.</td><td>Riparian condition: Poor
There was a narrow strip of vegetation around the perimeter of the waterway (2 m wide on the left bank and 3 m wide on the right bank), and the surrounding land had been impacted by extensive land clearing of the riparian zone. Vegetation consisted of grasses, shrubs and trees (predominantly Acacia). Banks were low (1 m high) and stable with little erosion. There were some exotic terrestrial weeds present at this site.</td><td>External Impacts: High
External impacts at the site were mostly associated with the surrounding land-use and included:
• disturbance to bank stability, vegetation and instream habitat from cattle access, and
• reduced riparian vegetation as a result of land clearing.</td><td>Water Quality:
<table><tr><th>Survey:</th><th>May ‘19</th><th>Oct ‘19</th></tr><tr><td>Condition:</td><td>Good</td><td>Dry</td></tr><tr><td>Temp (ºC):</td><td>21.3</td><td>—</td></tr><tr><td>EC (µS/cm):</td><td>385.7</td><td>—</td></tr><tr><td>DO (% sat):</td><td>111.2</td><td>—</td></tr><tr><td>pH (pH units):</td><td>8.24</td><td>—</td></tr><tr><td>Turbidity (NTU):</td><td>6.3</td><td>—</td></tr></table></td></tr>
</table>

<table>
<tr><th>Site: RCT4</th><th>Location: Adjacent to MLAs; Adjacent to Project area</th><th>Stream Order: 1</th><th>Waterway: Unnamed tributary of Ripstone Creek</th></tr>
<tr><td>Upstream: May 2019
  </td><td>Downstream: May 2019
  </td><td>Upstream: October 2019
  </td><td>Downstream: October 2019
  </td></tr>
<tr><td>Aquatic Ecosystem Value: Low</td><td>MNES/MSES: None present or likely to occur</td><td>Dry season refuge: No</td><td>Connectivity: Limited, due to downstream track crossing and extended dry periods</td></tr>
<tr><td>In-stream condition: Poor
Key habitat features in May included:
• limited aquatic plants
• woody debris
• periphyton
• a limited range of sediment grain sizes (including silt/clay and sand), and
• some trailing and overhanging bank vegetation.
The site consisted of a large shallow pool in May and was dry in October.</td><td>Riparian condition: Poor
The extent of riparian vegetation had been reduced by land clearing and cattle trampling (remaining vegetation zone was approx. 1 – 2 m wide). Vegetation consisted of predominantly grasses with some shrubs and trees (predominantly Eucalyptus). Banks were low (0.5 m – 1 m high) and gently sloping with erosion from cattle access. There were some exotic riparian species present at the site.</td><td>External Impacts: High
External impacts at the site were mostly associated with the surrounding land-use and included:
• alteration of the habitat to construct the downstream track crossing
• disturbance to bank stability and instream habitat from cattle access, and
• reduced riparian vegetation as a result of land clearing.</td><td>Water Quality:
<table><tr><th>Survey:</th><th>May ‘19</th><th>Oct ‘19</th></tr><tr><td>Condition:</td><td>Moderate</td><td>Dry</td></tr><tr><td>Temp (ºC):</td><td>24</td><td>—</td></tr><tr><td>EC (µS/cm):</td><td>306.5</td><td>—</td></tr><tr><td>DO (% sat):</td><td>132.7</td><td>—</td></tr><tr><td>pH (pH units):</td><td>8.16</td><td>—</td></tr><tr><td>Turbidity (NTU):</td><td>114.2</td><td>—</td></tr></table></td></tr>
</table>

<table>
<tr><th>Site: RCT5</th><th>Location: Adjacent to MLAs; Adjacent to Project area</th><th>Stream Order: 1</th><th colspan="3">Waterway: Unnamed tributary of Ripstone Creek</th></tr>
<tr><td>Left bank, downstream: October 2019
  </td><td>Right bank, downstream: October 2019
  </td><td>Upstream: October 2019
  </td><td colspan="3">Downstream: October 2019
  </td></tr>
<tr><td>Aquatic Ecosystem Value: Low</td><td>MNES/MSES: None present or likely to occur</td><td>Dry season refuge: No</td><td colspan="3">Connectivity: Limited, during periods of high flow</td></tr>
<tr><td rowspan="2">In-stream condition: Poor
Key potential habitat features in May included:
• woody debris
• terrestrial detritus
• a limited range of sediment grain sizes (including silt/clay and sand), and
• trailing and overhanging bank vegetation.
The site was not surveyed in May and was dry in October.</td><td rowspan="2">Riparian condition: Fair
The riparian zone consisted of a thin strip of vegetation that had been reduced by land clearing (remaining vegetation zone was approx. 5 m wide on both banks). Vegetation consisted of predominately grasses with some shrubs and trees (Eucalyptus). Banks were low (1 m high) and gently sloping with some erosion. There was extensive exotic weed species present at the site.</td><td rowspan="2">External Impacts: Moderate
External impacts at the site were mostly associated with the surrounding land-use and included:
• alteration of the habitat to construct a track crossing at the upstream extent of the site
• disturbance to bank stability and instream habitat from cattle access, and
• reduced riparian vegetation as a result of land clearing, particularly around the rail crossing.</td><td colspan="3">Water Quality:</td></tr>
<tr><td>Survey:</td><td>May ‘19</td><td>Oct ‘19</td></tr>
<tr><td></td><td>Condition:</td><td>Not surveyed</td><td>Dry</td></tr>
<tr><td></td><td>Temp (ºC):</td><td>—</td><td>—</td></tr>
<tr><td></td><td>EC (µS/cm):</td><td>—</td><td>—</td></tr>
<tr><td></td><td>DO (% sat):</td><td>—</td><td>—</td></tr>
<tr><td></td><td>pH (pH units):</td><td>—</td><td>—</td></tr>
<tr><td></td><td>Turbidity (NTU):</td><td>—</td><td>—</td></tr>
</table>

<table>
<tr><th>Site: LW4</th><th>Location: Upstream of MLAs; Adjacent to Project area</th><th>Stream Order: 1</th><th>Waterway: Mapped lacustrine wetland</th></tr>
<tr><td>Upstream: May 2019
  </td><td>Downstream: May 2019
  </td><td>Upstream: May 2019
  </td><td>Downstream: May 2019
  </td></tr>
<tr><td>Aquatic Ecosystem Value: Low</td><td>MNES/MSES: None present or likely to occur</td><td>Dry season refuge: Contains water year-round but very poor water quality</td><td colspan="3">Connectivity: Limited upstream and downstream by high dam walls</td></tr>
<tr><td>In-stream condition: Poor
Key habitat features in May included:
• shallow and deep pools, and
• sediment dominated by silt with some boulders.</td><td>Riparian condition: Poor
No riparian zone was present due to extensive clearing for construction of the dam and access tracks. Banks were high (approx. 5 m high) and gently sloping with minimal erosion. A moderate abundance of grass and terrestrial weeds was present along the banks.</td><td>External Impacts: High
This site consisted of an artificial dam that was part of a mine water management system.
There was no riparian vegetation and water quality was poor, with very high EC.</td><td colspan="3">Water Quality:
<table>
<tr><th>Survey:</th><th>May ‘19</th><th>Oct ‘19</th></tr>
<tr><td>Condition:</td><td>Poor</td><td>Not surveyed</td></tr>
<tr><td>Temp (ºC):</td><td>22.1</td><td>—</td></tr>
<tr><td>EC (µS/cm):</td><td>9364</td><td>—</td></tr>
<tr><td>DO (% sat):</td><td>153.6</td><td>—</td></tr>
<tr><td>pH (pH units):</td><td>8.75</td><td>—</td></tr>
<tr><td>Turbidity (NTU):</td><td>7</td><td>—</td></tr>
</table></td></tr>
</table>

<table>
<tr><th>Site: FD5</th><th>Location: Within MLA700050; Adjacent to Project area</th><th>Stream Order: 1</th><th>Waterway: Unmapped farm dam</th></tr>
<tr><td>Left bank, downstream: October 2019
  </td><td>Right bank, downstream: October 2019
  </td><td>Upstream: October 2019
  </td><td>Downstream: October 2019
  </td></tr>
<tr><td>Aquatic Ecosystem Value: Low</td><td>MNES/MSES: None present or likely to occur</td><td>Dry season refuge: Yes</td><td>Connectivity: Poor</td></tr>
<tr><td>In-stream condition: Poor
Key habitat features in October included:
• minimal coverage of aquatic plants
• a limited range of sediment grain sizes (predominantly silt/clay and sand)
• periphyton
• shallow and deep pools, and
• blanketing silt.
The site was only surveyed in October.</td><td>Riparian condition: Poor
The extent of the riparian zone had been reduced by land clearing, there was no riparian vegetation except for a small number of isolated mature trees (predominantly Eucalyptus and Acacia) upstream of the dam. Banks were high (5 m high) and gently sloping with minimal erosion. There was a moderate abundance of terrestrial weeds.</td><td>External Impacts: High
External impacts at the site were mostly associated with the surrounding land-use and included:
• alteration of habitat to construct the dam
• disturbance to bank stability and instream habitat from cattle access, and
• reduced riparian vegetation as a result of land clearing.</td><td>Water Quality:
<table>
<tr><th>Survey:</th><th>May ‘19</th><th>Oct ‘19</th></tr>
<tr><td>Condition:</td><td>Not surveyed</td><td>Moderate</td></tr>
<tr><td>Temp (ºC):</td><td>—</td><td>30.3</td></tr>
<tr><td>EC (µS/cm):</td><td>—</td><td>409.8</td></tr>
<tr><td>DO (% sat):</td><td>—</td><td>109.3</td></tr>
<tr><td>pH (pH units):</td><td>—</td><td>8.75</td></tr>
<tr><td>Turbidity (NTU):</td><td>—</td><td>12.7</td></tr>
</table></td></tr>
</table>

<table>
<tr><th>Site: FD6</th><th>Location: Within MLA700050; Adjacent to Project area</th><th>Stream Order: 1</th><th>Waterway: Unmapped farm dam on an unnamed tributary of Ripstone Creek</th></tr>
<tr><td>Left bank, downstream: October 2019
  </td><td>Right bank, downstream: October 2019
  </td><td>Upstream: October 2019
  </td><td>Downstream: October 2019
  </td></tr>
<tr><td>Aquatic Ecosystem Value: Moderate</td><td>MNES/MSES: None present or likely to occur</td><td>Dry season refuge: Yes</td><td colspan="3">Connectivity: Poor, due to high dam walls</td></tr>
<tr><td>In-stream condition: Fair
Key habitat features in October included:
• diverse range of aquatic plants
• a variety of woody debris
• a limited range of sediment grain sizes (predominately clay/silt)
• blanketing silt
• filamentous algae
• periphyton
• shallow and deep pools, and
• overhanging bank vegetation.
The site was only surveyed during October.</td><td>Riparian condition: Poor
The riparian zone was mostly continuous around the upstream channel (approx. 8 m wide) but the vegetation surrounding the dam had been cleared. Vegetation consisted of mostly grasses with some shrubs and small trees (predominantly Acacia with some Eucalyptus). Banks were low (1m – 3 m high) and gently sloping with some erosion. There were some exotic riparian species present at the site.</td><td>External Impacts: Moderate to high
External impacts at the site were mostly associated with the surrounding land-use and included:
• alteration of habitat to construct the dam
• disturbance to bank stability and instream habitat from cattle access, and
• reduced riparian vegetation as a result of land clearing.</td><td colspan="3">Water Quality:
<table><tr><th>Survey:</th><th>May ‘19</th><th>Oct ‘19</th></tr><tr><td>Condition:</td><td>Not surveyed</td><td>Moderate</td></tr><tr><td>Temp (ºC):</td><td>—</td><td>30</td></tr><tr><td>EC (µS/cm):</td><td>—</td><td>231.1</td></tr><tr><td>DO (% sat):</td><td>—</td><td>116.6</td></tr><tr><td>pH (pH units):</td><td>—</td><td>8.57</td></tr><tr><td>Turbidity (NTU):</td><td>—</td><td>8.7</td></tr></table></td></tr>
</table>

<table>
<tr><th>Site: U4</th><th>Location: Within MLA700049; Within Project area</th><th>Stream Order: 1</th><th>Waterway: Unmapped unnamed tributary of the Isaac River</th></tr>
<tr><td>Upstream: May 2019
  </td><td>Downstream: May 2019
  </td><td>Upstream: October 2019
  </td><td>Downstream: October 2019
  </td></tr>
<tr><td>Aquatic Ecosystem Value: Low</td><td>MNES/MSES: None present or likely to occur</td><td>Dry season refuge: No</td><td>Connectivity: Limited, to periods of high flow</td></tr>
<tr><td>In-stream condition: Poor
Key habitat features in May included:
• limited in stream habitat
• extensive in stream siltation
• periphyton
• a limited range of sediment grain sizes (including silt/clay and sand)
• substrate anoxia
• shallow and sandy pools, and
• limited trailing and overhanging bank vegetation.
The site consisted of a chain of shallow pools during the May survey and was dry in October.</td><td>Riparian condition: Poor
Riparian vegetation had been significantly reduced by land clearing and trampling (remaining vegetation zone was approx. 2 m wide). Vegetation consisted of predominately grasses with some shrubs and trees (including brigalow (Acacia harpophylla) and other Acacia spp.. Banks were low (1 m high) and gently sloping with some erosion. There were some exotic terrestrial weeds present at the site.</td><td>External Impacts: Moderate
External impacts at the site were mostly associated with the surrounding land-use and included:
• disturbance to bank stability and instream habitat from cattle access, and
• reduced riparian vegetation as a result of land clearing for grazing and cattle access.</td><td>Water Quality:
<table><tr><th>Survey:</th><th>May ‘19</th><th>Oct ‘19</th></tr><tr><td>Condition:</td><td>Moderate</td><td>Dry</td></tr><tr><td>Temp (ºC):</td><td>23.5</td><td>—</td></tr><tr><td>EC (µS/cm):</td><td>405.9</td><td>—</td></tr><tr><td>DO (% sat):</td><td>102.1</td><td>—</td></tr><tr><td>pH (pH units):</td><td>7.86</td><td>—</td></tr><tr><td>Turbidity (NTU):</td><td>148.5</td><td>—</td></tr></table></td></tr>
</table>

<table>
<tr><th>Site: LW1</th><th>Location: Within MLA700049; Within Project area</th><th>Stream Order: 1</th><th>Waterway: Mapped lacustrine wetland</th></tr>
<tr><td>Left bank, downstream: October 2019
  </td><td>Right bank: October 2019
  </td><td>Upstream: October 2019
  </td><td>Downstream: October 2019
  </td></tr>
<tr><td>Aquatic Ecosystem Value: Low</td><td>MNES/MSES: None present or likely to occur</td><td>Dry season refuge: No</td><td>Connectivity: Limited, would only hold water during periods of high flow</td></tr>
<tr><td>In-stream condition: Poor
Key potential habitat features included:
• limited woody debris consisting of detritus and sticks
• periphyton
• filamentous algae
• blanketing silt, and
• a limited range of sediment grain sizes (predominately silt/clay with some sand and boulders).
The site was only surveyed in October. Only remnant pools remained that were too shallow to be sampled.</td><td>Riparian condition: Poor
The riparian zone had been significantly reduced by vegetation clearing (remaining vegetation zone was approx. 10 m wide on the left bank and 0 m on the right bank). Vegetation consisted of a small amount of grasses, shrubs and trees. Banks were high (8 m high) and steep, with moderate levels of erosion. There were some exotic riparian species present at the site.</td><td>External Impacts: High
External impacts at the site were mostly associated with the surrounding land-use and included:
• disturbance to bank stability and instream habitat from cattle and feral animal access
• alteration of habitat to construct the dam, and
• reduced riparian vegetation as a result of land clearing.</td><td>Water Quality:
Survey: | May ‘19 | Oct ‘19
Condition: | Not surveyed | Low/Dry
Temp (ºC): | — | —
EC (µS/cm): | — | —
DO (% sat): | — | —
pH (pH units): | — | —
Turbidity (NTU): | — | —</td></tr>
</table>

<table>
<tr><th colspan="2">Site: LW2</th><th>Location: Within MLA700049; Within Project area</th><th>Stream Order: 1</th><th colspan="4">Waterway : Mapped lacustrine wetland</th></tr>
<tr><td colspan="2">Upstream: May 2019
  </td><td>Downstream: May 2019
  </td><td>Upstream: October 2019
  </td><td colspan="4">Downstream: October 2019
  </td></tr>
<tr><td colspan="2">Aquatic Ecosystem Value: Low</td><td>MNES/MSES: None present or likely to occur</td><td>Dry season refuge: No</td><td colspan="4">Connectivity: Poor</td></tr>
<tr><td colspan="2">In-stream condition: Poor
Key habitat features in May included:
• low coverage of emergent aquatic plants
• a variety of woody debris
• a wide range of sediment grain sizes (though predominately silt/clay)
• blanketing silt
• filamentous algae and periphyton
• shallow and deep pools, and
• little trailing bank vegetation.
The site consisted of two disconnected pools in May and was dry during October.</td><td>Riparian condition: Poor
There was extensive clearing of the riparian zone, with limited vegetation remaining. Vegetation consisted of mature trees (predominantly Eucalyptus), with some grasses and shrubs. Banks were low (1 m – 2 m high) with limited erosion. There were some exotic riparian species present at the site.</td><td>External Impacts: High
External impacts at the site were mostly associated with the surrounding land-use and included:
• alteration of habitat to construct the dam, with excavation piles around the broader area
• disturbance to bank stability and instream habitat from cattle and feral animal access, and
• reduced riparian vegetation as a result of land clearing.</td><td colspan="4">Water Quality:
<table><tr><th>Survey:</th><th>May ‘19</th><th>Oct ‘19</th></tr><tr><td>Condition:</td><td>Poor</td><td>Dry</td></tr><tr><td>Temp (ºC):</td><td>22.6</td><td>—</td></tr><tr><td>EC (µS/cm):</td><td>802</td><td>—</td></tr><tr><td>DO (% sat):</td><td>119.2</td><td>—</td></tr><tr><td>pH (pH units):</td><td>8.32</td><td>—</td></tr><tr><td>Turbidity (NTU):</td><td>28.7</td><td>—</td></tr></table></td></tr>
</table>

<table>
<tr><th>Site: LW3</th><th>Location: Within MLA700049; Within Project area</th><th>Stream Order: 1</th><th>Waterway: Mapped lacustrine wetland</th></tr>
<tr><td>Upstream: May 2019
  </td><td>Downstream: May 2019
  </td><td>Upstream: October 2019
  </td><td>Downstream: October 2019
  </td></tr>
<tr><td>Aquatic Ecosystem Value: Low</td><td>MNES/MSES: None present or likely to occur</td><td>Dry season refuge: Possible, but unlikely due to poor connectivity</td><td>Connectivity: Poor</td></tr>
<tr><td>In-stream condition: Poor
Key habitat features included:
• limited aquatic plants
• periphyton
• filamentous algae
• a range of sediment grain sizes (predominantly silt/clay with some sand, gravel, pebble and cobble), and
• shallow and deep pools.
The site was surveyed in both May and October. The water level was lower in October than in May.</td><td>Riparian condition: Poor
The riparian zone had been reduced by land clearing and there was no remaining riparian vegetation. The site was predominantly bare, with very few grasses and shrubs present. Banks were high (7 m high) and steep with extensive erosion on bare banks. There was a moderate abundance of terrestrial weeds along the upper banks.</td><td>External Impacts: High
External impacts at the site were mostly associated with the surrounding land-use and included:
• alteration of habitat for the dam construction
• disturbance to bank stability and instream habitat from cattle and feral animal access, and
• reduced riparian vegetation as a result of land clearing.</td><td>Water Quality:
<table><tr><th>Survey:</th><th>May ‘19</th><th>Oct ‘19</th></tr><tr><td>Condition:</td><td>Moderate</td><td>Poor</td></tr><tr><td>Temp (ºC):</td><td>20.3</td><td>34.9</td></tr><tr><td>EC (µS/cm):</td><td>240.6</td><td>739.9</td></tr><tr><td>DO (% sat):</td><td>94.9</td><td>20.7</td></tr><tr><td>pH (pH units):</td><td>8.68</td><td>7.51</td></tr><tr><td>Turbidity (NTU):</td><td>59.5</td><td>548</td></tr></table></td></tr>
</table>

<table>
<tr><th colspan="2">Site: FD2</th><th>Location: Within MLA700049; Within Project area</th><th>Stream Order: 2</th><th colspan="2">Waterway: Unmapped farm dam on an unnamed tributary of the Isaac River</th></tr>
<tr><td>Upstream: May 2019
  </td><td>Downstream: May 2019
  </td><td>Upstream: October 2019
  </td><td colspan="3">Downstream: October 2019
  </td></tr>
<tr><td colspan="2">Aquatic Ecosystem Value: Moderate</td><td>MNES/MSES: None present or likely to occur</td><td>Dry season refuge: Yes</td><td colspan="2">Connectivity: Limited, due to high dam walls</td></tr>
<tr><td colspan="2">In-stream condition: Fair
Key habitat features included:
• aquatic plants
• limited woody debris (detritus / sticks)
• a range of sediment grain sizes (predominately silt/clay with some sand, gravel and pebbles)
• blanketing silt
• filamentous algae and periphyton
• shallow and deep pools, and
• substrate anoxia.
The site was surveyed in both May and October. The water level was lower in October than in May.</td><td>Riparian condition: Poor
There was extensive clearing of the riparian zone, with little remaining riparian vegetation. Vegetation consisted of some grasses and shrubs, with isolated trees (predominantly Acacia). Banks were 4 m high, steep with little erosion. There was extensive coverage of exotic riparian species at the site.</td><td>External Impacts: Moderate
External impacts at the site were mostly associated with the surrounding land-use and included:
• alteration of the habitat to construct the dam, and
• reduced riparian vegetation as a result of land clearing.</td><td colspan="2">Water Quality:
<table><tr><th>Survey:</th><th>May ‘19</th><th>Oct ‘19</th></tr><tr><td>Condition:</td><td>Moderate</td><td>Poor</td></tr><tr><td>Temp (ºC):</td><td>20.3</td><td>26.4</td></tr><tr><td>EC (µS/cm):</td><td>309</td><td>319.2</td></tr><tr><td>DO (% sat):</td><td>93.7</td><td>111.7</td></tr><tr><td>pH (pH units):</td><td>8.14</td><td>9.75</td></tr><tr><td>Turbidity (NTU):</td><td>14.8</td><td>61.5</td></tr></table></td></tr>
</table>

<table>
<tr><th>Site: FD4</th><th>Location: Within MLA700050; Within Project area</th><th>Stream Order: 1</th><th>Waterway: Unmapped farm dam</th></tr>
<tr>
<td>Left bank, downstream: October 2019
  </td>
<td>Right bank, downstream: October 2019
  </td>
<td>Upstream: October 2019
  </td>
<td>Downstream: October 2019
  </td>
</tr>
<tr>
<td>Aquatic Ecosystem Value: Moderate</td>
<td>MNES/MSES: None present or likely to occur</td>
<td>Dry season refuge: Yes</td>
<td colspan="3">Connectivity: Poor due to high dam walls</td>
</tr>
<tr>
<td>In-stream condition: Fair
Key habitat features in October included:
• aquatic plants
• small woody debris (detritus and sticks)
• filamentous algae and periphyton
• blanketing silt
• a limited range of sediment grain sizes (predominantly silt/clay with some sand)
• shallow and deep pools, and
• trailing bank vegetation.
The site was only surveyed during October.</td>
<td>Riparian condition: Poor
The extent of the riparian vegetation had been significantly reduced by land clearing. There was no riparian vegetation immediately surrounding the dam although brigalow was present in the wider area. Vegetation consisted of grasses and shrubs. Banks were high (5 m high) and steep with minimal erosion. There were some exotic riparian species present at the site.</td>
<td>External Impacts: High
External impacts at the site were mostly associated with the surrounding land-use and included:
• alteration of habitat to construct the dam
• disturbance to bank stability and instream habitat from cattle access, and
• reduced riparian vegetation as a result of land clearing.</td>
<td colspan="3">Water Quality:
<table>
<tr><th>Survey:</th><th>May ‘19</th><th>Oct ‘19</th></tr>
<tr><td>Condition:</td><td>Not surveyed</td><td>Poor</td></tr>
<tr><td>Temp (ºC):</td><td>—</td><td>27.5</td></tr>
<tr><td>EC (µS/cm):</td><td>—</td><td>654</td></tr>
<tr><td>DO (% sat):</td><td>—</td><td>103.5</td></tr>
<tr><td>pH (pH units):</td><td>—</td><td>8.39</td></tr>
<tr><td>Turbidity (NTU):</td><td>—</td><td>49.6</td></tr>
</table>
</td>
</tr>
</table>

<table>
<tr><th>Site: U1</th><th>Location: Within MLA700049; Downstream of Project area</th><th>Stream Order: 2</th><th>Waterway: Unnamed tributary of the Isaac River</th></tr>
<tr><td>Upstream: May 2019
  </td><td>Downstream: May 2019
  </td><td>Upstream: October 2019
  </td><td>Downstream: October 2019
  </td></tr>
<tr><td>Aquatic Ecosystem Value: Moderate</td><td>MNES/MSES: None present or likely to occur</td><td>Dry season refuge: No</td><td>Connectivity: Good, but only during periods of high flow</td></tr>
<tr><td>In-stream condition: Fair
Key habitat features in May included:
• aquatic plants
• a variety of woody debris
• periphyton
• blanketing silt
• a range of sediment grain sizes (predominately silt/clay with some sand and boulders)
• shallow pools, and
• trailing and overhanging bank vegetation.
The site consisted of a series of isolated shallow pools in May and was dry during October.</td><td>Riparian condition: Moderate
The vegetation surrounding the site had been significantly reduced by land clearing (remaining vegetation zone was approx. 2 - 5 m wide), however there was good coverage of riparian vegetation upstream and downstream of the site. Vegetation consisted of grass, shrubs and trees (predominantly Eucalyptus). Banks were low (1.5 m high) and gently sloping with minimal erosion. There was a moderate abundance of terrestrial weeds.</td><td>External Impacts: Moderate
External impacts at the site were mostly associated with the surrounding land-use and included reduced riparian vegetation as a result of land clearing.</td><td>Water Quality:
<table><tr><th>Survey:</th><th>May ‘19</th><th>Oct ‘19</th></tr><tr><td>Condition:</td><td>Good</td><td>Dry</td></tr><tr><td>Temp (ºC):</td><td>20.7</td><td>—</td></tr><tr><td>EC (µS/cm):</td><td>223.4</td><td>—</td></tr><tr><td>DO (% sat):</td><td>83</td><td>—</td></tr><tr><td>pH (pH units):</td><td>7.57</td><td>—</td></tr><tr><td>Turbidity (NTU):</td><td>33</td><td>—</td></tr></table></td></tr>
</table>

<table>
<tr><th>Site: U2</th><th>Location: Within MLA700050; Downstream of Project area</th><th>Stream Order: 2</th><th>Waterway: Unnamed tributary of the Isaac River</th></tr>
<tr><td>Upstream: May 2019
  </td><td>Downstream: May 2019
  </td><td>Upstream: October 2019
  </td><td>Downstream: October 2019
  </td></tr>
<tr><td>Aquatic Ecosystem Value: Low</td><td>MNES/MSES: None present or likely to occur</td><td>Dry season refuge: No</td><td>Connectivity: Good, but only during periods of high flow</td></tr>
<tr><td>In-stream condition: Poor
Key potential habitat features included:
• a variety of woody debris including detritus, sticks, branches and logs
• a range of sediment grain sizes (predominately silt/clay with some sand, gravel, pebble, cobble and boulders)
• blanketing silt, and
• trailing and overhanging bank vegetation.
The site was dry during both the May and October surveys.</td><td>Riparian condition: Poor to fair
There was a thin strip of riparian vegetation (approx. 5 m wide on the left bank and 10 m wide on the right bank) at the perimeter of the waterway. Surrounding vegetation had been reduced by land clearing. Vegetation consisted of mature trees (predominantly Eucalyptus and Casuarina). Banks were low (1.5 m high) and gently sloping with moderate erosion. There was a moderate amount of exotic riparian species present at the site.</td><td>External Impacts: Moderate
External impacts at the site were mostly associated with the surrounding land-use and included:
• disturbance to bank stability and instream habitat from cattle access, and
• reduced riparian vegetation as a result of land clearing.</td><td colspan="2">Water Quality:
<table><tr><th>Survey:</th><th>May ‘19</th><th>Oct ‘19</th></tr><tr><td>Condition:</td><td>Dry</td><td>Dry</td></tr><tr><td>Temp (ºC):</td><td>—</td><td>—</td></tr><tr><td>EC (µS/cm):</td><td>—</td><td>—</td></tr><tr><td>DO (% sat):</td><td>—</td><td>—</td></tr><tr><td>pH (pH units):</td><td>—</td><td>—</td></tr><tr><td>Turbidity (NTU):</td><td>—</td><td>—</td></tr></table></td></tr>
</table>

<table>
<tr><th>Site: U5</th><th>Location: Within MLA700050; Downstream of Project area</th><th>Stream Order: 1</th><th>Waterway: Unnamed tributary of the Isaac River</th></tr>
<tr><td>Left bank, downstream: October 2019
  </td><td>Right bank, downstream: October 2019
  </td><td>Upstream: October 2019
  </td><td>Downstream: October 2019
  </td></tr>
<tr><td>Aquatic Ecosystem Value: Low</td><td>MNES/MSES: None present or likely to occur</td><td>Dry season refuge: No</td><td>Connectivity: Poor</td></tr>
<tr><td>In-stream condition: Poor
Key potential habitat features included:
• low diversity of aquatic plants
• minimal woody debris
• a limited range of sediment grain sizes (including silt/clay and sand)
• limited canopy cover, and
• limited trailing and overhanging bank vegetation.
The site was only surveyed during October when it was dry.</td><td>Riparian condition: Poor
The riparian zone had been reduced by land clearing (remaining vegetation zone was approx. 1 m wide). Vegetation consisted of grasses, shrubs and some small trees (predominantly Acacia). Banks were low (0.5 m high) and gently sloping with some erosion. There were some exotic riparian species present at the site.</td><td>External Impacts: High
External impacts at the site were mostly associated with the surrounding land-use and included:
• disturbance to bank stability and instream habitat from cattle access, and
• reduced riparian vegetation as a result of land clearing.</td><td>Water Quality:
<table><tr><th>Survey:</th><th>May ‘19</th><th>Oct ‘19</th></tr><tr><td>Condition:</td><td>Not surveyed</td><td>Dry</td></tr><tr><td>Temp (ºC):</td><td>—</td><td>—</td></tr><tr><td>EC (µS/cm):</td><td>—</td><td>—</td></tr><tr><td>DO (% sat):</td><td>—</td><td>—</td></tr><tr><td>pH (pH units):</td><td>—</td><td>—</td></tr><tr><td>Turbidity (NTU):</td><td>—</td><td>—</td></tr></table></td></tr>
</table>

<table>
<tr><th>Site: U6</th><th>Location: Downstream of MLAs; Downstream of Project area</th><th>Stream Order: 1</th><th>Waterway: Unnamed tributary of the Isaac River</th></tr>
<tr><td>Left bank, downstream: October 2019
  </td><td>Right bank, downstream: October 2019
  </td><td>Upstream: October 2019
  </td><td>Downstream: October 2019
  </td></tr>
<tr><td>Aquatic Ecosystem Value: Low</td><td>MNES/MSES: None present or likely to occur</td><td>Dry season refuge: No</td><td>Connectivity: Limited, downstream of farm dam and would only be connected during periods of high rainfall.</td></tr>
<tr><td>In-stream condition: Moderate
Key potential habitat features included:
• a range of woody debris (including detritus, sticks, branches and logs)
• a limited range of sediment grain sizes (including silt/clay and sand)
• moderate canopy cover, and
• trailing and overhanging bank vegetation.
The site was only surveyed during October when it was dry.</td><td>Riparian condition: Fair
The riparian zone consisted of continuous vegetation around the perimeter of the waterway. Vegetation consisted of mature trees (predominantly Eucalyptus and Acacia). Banks were low (0.5 m) and steep with extensive erosion. There were some exotic riparian species present at the site.</td><td>External Impacts: Moderate
External impacts at the site were mostly associated with the surrounding land-use and included:
• alteration of habitat to construct a dam upstream, and
• disturbance to bank stability and instream habitat from cattle and feral animal access.</td><td>Water Quality:
<table>
<tr><th>Survey:</th><th>May ‘19</th><th>Oct ‘19</th></tr>
<tr><td>Condition:</td><td>Not surveyed</td><td>Dry</td></tr>
<tr><td>Temp (ºC):</td><td>—</td><td>—</td></tr>
<tr><td>EC (µS/cm):</td><td>—</td><td>—</td></tr>
<tr><td>DO (% sat):</td><td>—</td><td>—</td></tr>
<tr><td>pH (pH units):</td><td>—</td><td>—</td></tr>
<tr><td>Turbidity (NTU):</td><td>—</td><td>—</td></tr>
</table></td></tr>
</table>

<table>
<tr><th>Site: U7</th><th>Location: Within MLA700050; Downstream of Project area</th><th>Stream Order: 1</th><th>Waterway: Unnamed tributary of the Isaac River</th></tr>
<tr><td>Upstream: October 2019
  </td><td>Downstream: October 2019
  </td><td>Upstream: October 2019
  </td><td>Downstream: October 2019
  </td></tr>
<tr><td>Aquatic Ecosystem Value: Low</td><td>MNES/MSES: None present or likely to occur</td><td>Dry season refuge: Possible - Unlikely</td><td colspan="3">Connectivity: Moderate, during periods of high flow</td></tr>
<tr><td>In-stream condition: Poor
Key potential habitat features included:
• some woody debris (detritus, sticks, branches and logs)
• a limited range of sediment grain sizes (including silt/clay, sand and gravel)
• some canopy cover, and
• some trailing and overhanging bank vegetation.
The site was only surveyed during October when it was dry.</td><td>Riparian condition: Poor
The riparian zone had been extensively cleared for grazing with only thin sections of riparian vegetation remaining (vegetation was approximately 5m wide). Vegetation consisted of Eucalyptus and Acacia (up to 10m high). Banks were low (0.5m) with a gentle slope and minimal erosion. There were some exotic riparian species at the site.</td><td>External Impacts: High
External impacts at the site were mostly associated with the surrounding land-use and included:
• reduced riparian vegetation as a result of land clearing, and
• disturbance to bank stability and instream habitat from cattle.</td><td colspan="3">Water Quality:
<table><tr><th>Survey:</th><th>May ‘19</th><th>Oct ‘19</th></tr><tr><td>Condition:</td><td>Not surveyed</td><td>Dry</td></tr><tr><td>Temp (ºC):</td><td>—</td><td>—</td></tr><tr><td>EC (µS/cm):</td><td>—</td><td>—</td></tr><tr><td>DO (% sat):</td><td>—</td><td>—</td></tr><tr><td>pH (pH units):</td><td>—</td><td>—</td></tr><tr><td>Turbidity (NTU):</td><td>—</td><td>—</td></tr></table></td></tr>
</table>

<table>
<tr><th>Site: I1a</th><th>Location: Downstream of MLAs; Downstream of Project area</th><th>Stream Order: 6</th><th>Waterway: Isaac River</th></tr>
<tr><td>Left bank, downstream: October 2019
  </td><td>Right bank, downstream: October 2019
  </td><td>Upstream: October 2019
  </td><td>Downstream: October 2019
  </td></tr>
<tr><td>Aquatic Ecosystem Value: Moderate</td><td>MNES/MSES: None present or likely to occur</td><td>Dry season refuge: Yes</td><td>Connectivity: Good, during periods of flow</td></tr>
<tr><td>In-stream condition: Good
Key habitat features in October included:
• instream sandy bars
• aquatic plants
• large woody debris
• a limited range of sediment grain sizes (predominately sand with some silt/clay)
• shallow and deep pools, and
• trailing and overhanging bank vegetation.
The site was only surveyed during October.</td><td>Riparian condition: Good
The riparian zone was mostly continuous although the extent of the vegetation had been reduced by land clearing for grazing (remaining vegetation zone was approx. 10 m wide). Vegetation consisted of mature trees (predominantly Eucalyptus and Melaleuca). Banks were high (7 m high) and gently sloping with some erosion. There were some exotic riparian species present at the site.</td><td>External Impacts: Moderate
External impacts at the site were mostly associated with the surrounding land-use and included:
• disturbance to bank stability and instream habitat from cattle access, and
• reduced vegetation in the broader area as a result of land clearing.</td><td>Water Quality:
<table>
<tr><th>Survey:</th><th>May ‘19</th><th>Oct ‘19</th></tr>
<tr><td>Condition:</td><td>Not surveyed</td><td>Good</td></tr>
<tr><td>Temp (ºC):</td><td>—</td><td>26.9</td></tr>
<tr><td>EC (µS/cm):</td><td>—</td><td>708</td></tr>
<tr><td>DO (% sat):</td><td>—</td><td>62.3</td></tr>
<tr><td>pH (pH units):</td><td>—</td><td>7.91</td></tr>
<tr><td>Turbidity (NTU):</td><td>—</td><td>44.6</td></tr>
</table></td></tr>
</table>

<table>
<tr><th>Site: I2a</th><th>Location: Downstream of MLAs; Downstream of Project area</th><th>Stream Order: 6</th><th>Waterway: Isaac River</th></tr>
<tr><td>Upstream: May 2019
  </td><td>Downstream: May 2019
  </td><td>Upstream: October 2019
  </td><td>Downstream: October 2019
  </td></tr>
<tr><td>Aquatic Ecosystem Value: Moderate</td><td>MNES/MSES: None present or likely to occur</td><td>Dry season refuge: No</td><td colspan="3">Connectivity: Good, during periods of high flow</td></tr>
<tr><td>In-stream condition: Fair
Key habitat features in May included:
• aquatic plants and periphyton
• a range of woody debris
• filamentous algae
• blanketing silt
• a range of sediment grain sizes (sand with some silt/clay, grave, pebble, cobble, boulder, and bed rock)
• shallow, rocky and sandy pools, and
• trailing and overhanging bank vegetation.
The site consisted of shallow isolated pools in May and was dry in October.</td><td>Riparian condition: Fair
The riparian zone was mostly continuous on the left bank of the waterway, although the extent of the vegetation had been reduced by land clearing (remaining vegetation zone was continuous on left bank and approx. 7 m wide on right bank). Vegetation consisted of grasses, shrubs and trees (predominantly Eucalyptus and Melaleuca). Banks were high (approx. 6 m high) and gently sloping with some erosion. There were exotic riparian species present at the site.</td><td>External Impacts: Moderate
External impacts at the site were mostly associated with the surrounding land-use and included:
• disturbance to bank stability and instream habitat from cattle access, and
• reduced riparian vegetation as a result of land clearing for grazing and track crossing.</td><td colspan="3">Water Quality:
<table><tr><th>Survey:</th><th>May ‘19</th><th>Oct ‘19</th></tr><tr><td>Condition:</td><td>Good</td><td>Dry</td></tr><tr><td>Temp (ºC):</td><td>21.2</td><td>—</td></tr><tr><td>EC (µS/cm):</td><td>364.8</td><td>—</td></tr><tr><td>DO (% sat):</td><td>96.7</td><td>—</td></tr><tr><td>pH (pH units):</td><td>8.0</td><td>—</td></tr><tr><td>Turbidity (NTU):</td><td>14.0</td><td>—</td></tr></table></td></tr>
</table>

<table>
<tr><th>Site: I3</th><th>Location: Downstream of MLAs; Downstream of Project area</th><th>Stream Order: 6</th><th>Waterway: Isaac River</th></tr>
<tr><td>Upstream: May 2019
  </td><td>Downstream: May 2019
  </td><td>Upstream: October 2019
  </td><td>Downstream: October 2019
  </td></tr>
<tr><td>Aquatic Ecosystem Value: Moderate</td><td>MNES/MSES: None present or likely to occur</td><td>Dry season refuge: No</td><td>Connectivity: Good, during periods of high flow</td></tr>
<tr><td>In-stream condition: Good
Key habitat features in May included:
• aquatic plants and periphyton
• a variety of woody debris including detritus, sticks, branches and logs
• blanketing silt
• undercut banks
• a limited range of sediment grain sizes (predominately sand with some silt/clay)
• shallow, deep and sandy pools, and
• trailing and overhanging bank vegetation.
The site consisted of several isolated pools during the May survey and was dry in October.</td><td>Riparian condition: Moderate
The riparian zone was mostly continuous, although the extent of the vegetation had been reduced by land clearing for tracks (remaining vegetation zone was approx. 20 m wide on right bank and continuous on the left bank). Vegetation consisted of a moderate cover of grasses, shrubs and trees (predominantly Eucalyptus and Casuarina). Banks were high (7 m high) and steep with minimal erosion. There were some exotic riparian species present at this site.</td><td>External Impacts: Moderate
External impacts at the site were mostly associated with the surrounding land-use and included:
• some disturbance to bank stability and instream habitat from cattle access, and
• reduced riparian vegetation as a result of land clearing for tracks and grazing.</td><td>Water Quality:
<table><tr><th>Survey:</th><th>May ‘19</th><th>Oct ‘19</th></tr><tr><td>Condition:</td><td>Good</td><td>Dry</td></tr><tr><td>Temp (ºC):</td><td>24.9</td><td>—</td></tr><tr><td>EC (µS/cm):</td><td>270.2</td><td>—</td></tr><tr><td>DO (% sat):</td><td>97.5</td><td>—</td></tr><tr><td>pH (pH units):</td><td>7.61</td><td>—</td></tr><tr><td>Turbidity (NTU):</td><td>31.6</td><td>—</td></tr></table></td></tr>
</table>

<table>
<tr><th colspan="2">Site: PW1</th><th>Location: Downstream of MLAs; Downstream of Project area</th><th>Stream Order: 1</th><th colspan="3">Waterway: Mapped HES/WPA palustrine wetland in Isaac River floodplain</th></tr>
<tr><td colspan="2">Upstream: May 2019
  </td><td>Downstream: May 2019
  </td><td>Upstream: October 2019
  </td><td colspan="3">Downstream: October 2019
  </td></tr>
<tr><td colspan="2">Aquatic Ecosystem Value: Low</td><td>MNES/MSES: None present or likely to occur</td><td>Dry season refuge: No</td><td colspan="3">Connectivity: Limited, would only hold water during periods of high rainfall</td></tr>
<tr><td colspan="2">In-stream condition: Good
Key potential habitat features included:
• aquatic plants
• a variety of woody debris including detritus, sticks, branches and logs
• canopy cover and shading
• a limited range of sediment grain sizes (predominately silt/clay with some sand), and
• trailing and overhanging bank vegetation.
The site was dry during both the May and October surveys.</td><td>Riparian condition: Good
The riparian zone was mostly continuous around the perimeter of the wetland. Vegetation consisted of grasses, shrubs, and trees (predominantly Eucalyptus). Banks were low (0.2 m high) and gently sloping with some erosion. There were some exotic riparian species present at the site.</td><td>External Impacts: Minimal
External impacts at the site were mostly associated with the surrounding land-use and included:
· some land clearing throughout the broader area, and
· grazing by cattle.</td><td colspan="3">Water Quality:
<table><tr><th>Survey:</th><th>May ‘19</th><th>Oct ‘19</th></tr><tr><td>Condition:</td><td>Dry</td><td>Dry</td></tr><tr><td>Temp (ºC):</td><td>—</td><td>—</td></tr><tr><td>EC (µS/cm):</td><td>—</td><td>—</td></tr><tr><td>DO (% sat):</td><td>—</td><td>—</td></tr><tr><td>pH (pH units):</td><td>—</td><td>—</td></tr><tr><td>Turbidity (NTU):</td><td>—</td><td>—</td></tr></table></td></tr>
</table>

<table>
<tr><th>Site: PW2</th><th>Location: Within MLA700049; Downstream of Project area</th><th>Stream Order: 1</th><th>Waterway : Mapped palustrine wetland</th></tr>
<tr><td>Upstream: May 2019
  </td><td>Downstream: May 2019
  </td><td>Upstream: October 2019
  </td><td>Downstream: October 2019
  </td></tr>
<tr><td>Aquatic Ecosystem Value: Low</td><td>MNES/MSES: None present or likely to occur</td><td>Dry season refuge: No</td><td>Connectivity: Limited, would only hold water during periods of high flow</td></tr>
<tr><td>In-stream condition: Moderate
Key potential habitat features included:
• high diversity of aquatic plants
• small and large woody debris including logs
• a limited range of sediment grain sizes (including silt/clay and some sand)
• blanketing silt, and
• trailing and overhanging bank vegetation.
The site was dry during both the May and October surveys.</td><td>Riparian condition: Good
The riparian zone was mostly continuous around the perimeter of the wetland. Vegetation consisted of grasses, shrubs and trees (predominantly Eucalyptus and brigalow (Acacia harpophylla)). Banks were low (0.3 m high), with minimal slope. There were some exotic riparian species present at the site.</td><td>External Impacts: Minimal
External impacts at the site were mostly associated with the surrounding land-use and included:
• disturbance to vegetation and potential instream habitat from cattle access, and
• land clearing in the broader region.</td><td>Water Quality:
<table><tr><th>Survey:</th><th>May ‘19</th><th>Oct ‘19</th></tr><tr><td>Condition:</td><td>Dry</td><td>Dry</td></tr><tr><td>Temp (ºC):</td><td>—</td><td>—</td></tr><tr><td>EC (µS/cm):</td><td>—</td><td>—</td></tr><tr><td>DO (% sat):</td><td>—</td><td>—</td></tr><tr><td>pH (pH units):</td><td>—</td><td>—</td></tr><tr><td>Turbidity (NTU):</td><td>—</td><td>—</td></tr></table></td></tr>
</table>

<table>
<tr><th>Site: PW3</th><th>Location: Within MLA700050; Downstream of Project area</th><th>Stream Order: 1</th><th>Waterway: Mapped palustrine wetland</th></tr>
<tr><td>Upstream: May 2019
  </td><td>Downstream: May 2019
  </td><td>Upstream: October 2019
  </td><td>Downstream: October 2019
  </td></tr>
<tr><td>Aquatic Ecosystem Value: Low</td><td>MNES/MSES: None present or likely to occur</td><td>Dry season refuge: No</td><td>Connectivity: Limited, would only hold water during periods of high flow</td></tr>
<tr><td>In-stream condition: Moderate
Key potential habitat features included:
• aquatic plants
• a range of woody debris including detritus, sticks, branches and logs
• canopy cover and shading of the reach
• a limited range of sediment grain sizes (including silt/clay and sand), and
• trailing and overhanging bank vegetation.
The site was dry during both the May and October surveys, and most of the aquatic plants in the dry bed had died back in the October survey.</td><td>Riparian condition: Moderate
The riparian zone was mostly continuous around the perimeter of the wetland, although the extent of the vegetation had been reduced by land clearing in some sections (remaining vegetation zone was approx. 10 m wide). Vegetation consisted of grass, shrubs and trees (predominantly Eucalyptus). Banks were low (0.3 m), with little slope and some erosion. There were some exotic riparian species present at the site.</td><td>External Impacts: Moderate
External impacts at the site were mostly associated with the surrounding land-use and included:
• disturbance to bank stability and potential instream habitat from cattle access, and
• reduced riparian vegetation as a result of land clearing for grazing and road tracks.</td><td>Water Quality:
<table><tr><th>Survey:</th><th>May ‘19</th><th>Oct ‘19</th></tr><tr><td>Condition:</td><td>Dry</td><td>Dry</td></tr><tr><td>Temp (ºC):</td><td>—</td><td>—</td></tr><tr><td>EC (µS/cm):</td><td>—</td><td>—</td></tr><tr><td>DO (% sat):</td><td>—</td><td>—</td></tr><tr><td>pH (pH units):</td><td>—</td><td>—</td></tr><tr><td>Turbidity (NTU):</td><td>—</td><td>—</td></tr></table></td></tr>
</table>

<table>
<tr><th>Site: PW4</th><th>Location: Downstream of MLAs; Downstream of Project area</th><th>Stream Order: 1</th><th>Waterway : Mapped palustrine wetland in Isaac River floodplain</th></tr>
<tr><td>Upstream: May 2019
  </td><td>Downstream: May 2019
  </td><td>Upstream: October 2019
  </td><td>Downstream: October 2019
  </td></tr>
<tr><td>Aquatic Ecosystem Value: Low</td><td>MNES/MSES: None present or likely to occur</td><td>Dry season refuge: No</td><td>Connectivity: Limited, would only hold water during periods of high flow</td></tr>
<tr><td>In-stream condition: Fair
Key potential habitat features included:
• aquatic plants
• variety of woody debris including detritus, sticks, branches and logs
• a limited range of sediment grain sizes (including silt/clay and sand), and
• trailing and overhanging bank vegetation.
The site was dry during both the May and October surveys.</td><td>Riparian condition: Good
The riparian zone was mostly continuous around the perimeter of the wetland, with limited clearing. Vegetation consisted of grasses, shrubs and trees (predominantly Eucalyptus). Banks were low (1 m high), with minimal slope and erosion. There was a moderate abundance of exotic riparian species present at the site.</td><td>External Impacts: Moderate
External impacts at the site were mostly associated with the surrounding land-use and included:
• disturbance to bank stability, vegetation and instream habitat from cattle access.</td><td>Water Quality:
<table><tr><th>Survey:</th><th>May ‘19</th><th>Oct ‘19</th></tr><tr><td>Condition:</td><td>Dry</td><td>Dry</td></tr><tr><td>Temp (ºC):</td><td>—</td><td>—</td></tr><tr><td>EC (µS/cm):</td><td>—</td><td>—</td></tr><tr><td>DO (% sat):</td><td>—</td><td>—</td></tr><tr><td>pH (pH units):</td><td>—</td><td>—</td></tr><tr><td>Turbidity (NTU):</td><td>—</td><td>—</td></tr></table></td></tr>
</table>

<table>
<tr><th>Site: LW5</th><th>Location: Downstream of MLAs; Downstream of Project area</th><th>Stream Order: 2</th><th>Waterway: Mapped lacustrine wetland</th></tr>
<tr><td>Left bank, downstream: October 2019
  </td><td>Right bank, downstream: October 2019
  </td><td>Upstream: October 2019
  </td><td>Downstream: October 2019
  </td></tr>
<tr><td>Aquatic Ecosystem Value: Low</td><td>MNES/MSES: None present or likely to occur</td><td>Dry season refuge: Yes</td><td>Connectivity: Limited upstream and downstream by high dam walls</td></tr>
<tr><td>In-stream condition: Poor
Key habitat features in October included:
• low diversity of aquatic plants
• a limited range of sediment grain sizes (including silt/clay and sand)
• periphyton
• filamentous algae
• shallow and deep pools, and
• blanketing silt.
The site was only surveyed in October.</td><td>Riparian condition: Poor to Fair
There was continuous riparian vegetation in wider area surrounding the dam. However, the riparian vegetation had been reduced by land clearing along the immediate perimeter of the dam. Vegetation consisted of grasses, shrubs and trees (predominantly Eucalyptus). Banks were relatively low (3 m high) and gently sloping, with some erosion. There were some exotic riparian species present on the site.</td><td>External Impacts: High
External impacts at the site were mostly associated with the surrounding land-use and included:
• alteration of the habitat to construct the dam
• reduced riparian vegetation as a result of land clearing
• tilapia nests observed at site, and
• disturbance to bank stability and instream habitat from cattle access.</td><td>Water Quality:
<table><tr><th>Survey:</th><th>May ‘19</th><th>Oct ‘19</th></tr><tr><td>Condition:</td><td>Not surveyed</td><td>Poor</td></tr><tr><td>Temp (ºC):</td><td>—</td><td>28.6</td></tr><tr><td>EC (µS/cm):</td><td>—</td><td>677</td></tr><tr><td>DO (% sat):</td><td>—</td><td>93.7</td></tr><tr><td>pH (pH units):</td><td>—</td><td>8.67</td></tr><tr><td>Turbidity (NTU):</td><td>—</td><td>49.1</td></tr></table></td></tr>
</table>

<table>
<tr><th colspan="2">Site: FD3</th><th>Location: Within MLA700049; Downstream of Project area</th><th>Stream Order: 2</th><th colspan="4">Waterway: Unmapped farm dam on an unnamed tributary of the Isaac River</th></tr>
<tr><td colspan="2">Left bank, downstream: October 2019
  </td><td>Right bank, downstream: October 2019
  </td><td>Upstream: October 2019
  </td><td colspan="4">Downstream: October 2019
  </td></tr>
<tr><td colspan="2">Aquatic Ecosystem Value: Low</td><td>MNES/MSES: None present or likely to occur</td><td>Dry season refuge: Yes, but poor quality habitat</td><td colspan="4">Connectivity: Poor, due to high dam walls</td></tr>
<tr><td colspan="2" rowspan="2">In-stream condition: Poor
Key habitat features in October included:
• lack of in-stream habitat structure, and
• a limited range of sediment grain sizes (silt/clay and sand).
The site was only surveyed during October.</td><td rowspan="2">Riparian condition: Poor
The riparian zone had been extensively cleared. Vegetation consisted of a limited coverage of grasses and shrubs. Both banks were high with a 3m lower and 5m upper height. There was a small abundance of terrestrial weeds.</td><td rowspan="2">External Impacts: High
External impacts at the site were greatly associated with the surrounding land-use and included:
• alteration of the waterway for dam construction
• cleared riparian vegetation for grazing, and
• disturbance to bank stability and instream habitat from cattle access.</td><td colspan="4">Water Quality:</td></tr>
<tr><td>Survey:</td><td>May ‘19</td><td>Oct ‘19</td></tr>
<tr><td></td><td>Condition:</td><td>Not surveyed</td><td>Moderate</td></tr>
<tr><td></td><td>Temp (ºC):</td><td>—</td><td>29.4</td></tr>
<tr><td></td><td>EC (µS/cm):</td><td>—</td><td>471</td></tr>
<tr><td></td><td>DO (% sat):</td><td>—</td><td>99</td></tr>
<tr><td></td><td>pH (pH units):</td><td>—</td><td>8.34</td></tr>
<tr><td></td><td>Turbidity (NTU):</td><td>—</td><td>21</td></tr>
</table>

<table>
<tr><th>Site: FD7</th><th>Location: Within MLA700051; Downstream of Project area</th><th>Stream Order: 1</th><th>Waterway: Unmapped farm dam on an unnamed tributary of the Isaac River</th></tr>
<tr><td>Upstream: October 2019
  </td><td>Downstream: October 2019
  </td><td>Upstream: October 2019
  </td><td>Downstream: October 2019
  </td></tr>
<tr><td>Aquatic Ecosystem Value: Low</td><td>MNES/MSES: None present or likely to occur</td><td>Dry season refuge: Yes</td><td>Connectivity: Limited upstream and downstream by high dam walls</td></tr>
<tr><td>In-stream condition: Poor
Key habitat features in October included:
• a range of sediment grain sizes (predominantly silt/clay & sand, but also some boulders, cobble, pebbles and gravel)
• periphyton
• shallow and deep pools, and
• blanketing silt.
The site was only surveyed during October.</td><td>Riparian condition: Poor
There was no riparian vegetation directly surrounding the dam due to land clearing, however there was good vegetation coverage in the wider area. The dam wall banks were 3 m high downstream of the dam and 0.5 m high upstream of the dam. The walls were gently sloping with minimal erosion. There were some exotic riparian species present at the site.</td><td>External Impacts: High
External impacts at the site were mostly associated with the surrounding land-use and included:
• alteration to the habitat to construct the dam
• reduced riparian vegetation as a result of land clearing and
• disturbance to bank stability and instream habitat from cattle access.</td><td>Water Quality:
<table>
<tr><th>Survey:</th><th>May ‘19</th><th>Oct ‘19</th></tr>
<tr><td>Condition:</td><td>Not surveyed</td><td>Moderate</td></tr>
<tr><td>Temp (ºC):</td><td>—</td><td>30.8</td></tr>
<tr><td>EC (µS/cm):</td><td>—</td><td>522</td></tr>
<tr><td>DO (% sat):</td><td>—</td><td>90.5</td></tr>
<tr><td>pH (pH units):</td><td>—</td><td>8.32</td></tr>
<tr><td>Turbidity (NTU):</td><td>—</td><td>19.4</td></tr>
</table></td></tr>
</table>

Appendix D Aquatic Plant Species Recorded from the Region

Table 9.2 Aquatic plants recorded from the region

Family *Species Name*	Common Name	Isaac River Sub-Basin[a]	DPM Enviro-sciences[b]	frc environmental[c]
Alismataceae				
Caldesia oligococca	NA	Yes	–	–
Amaryllidaceae				
Crinum flaccidum	Murray lily	Yes	–	–
Apocynaceae				
Gymnanthera oblonga	NA	Yes	–	–
Aponogetonaceae				
Aponogeton queenslandicus	NA	Yes	–	–
Araceae				
Spirodela oligorrhiza	NA	Yes	Yes	–
Asteraceae				
*Eclipta prostrata**	white eclipta	Yes	Yes	–
Brassicaceae				
*Rorippa nasturtium-aquaticum**	watercress	Yes	–	–
Casuarinaceae				
Casuarina cunninghamiana	NA	Yes	–	–
Casuarina cunninghamiana subsp. cunninghamiana	NA	Yes	–	–
Cyperaceae				
Cyperus alopecuroides	NA	Yes	–	–
Cyperus betchei	NA	Yes	–	Yes
Cyperus cristulatus	NA	Yes	–	–
Cyperus difformis	rice sedge	Yes	Yes	Yes
Cyperus digitatus	NA	Yes	–	–
Cyperus distans	NA	Yes	–	–
Cyperus enervis	NA	Yes	–	–
*Cyperus esculentus**	yellow nutgrass	Yes	–	–
Cyperus exaltatus	tall flatsedge	Yes	Yes	–
Cyperus flaccidus	NA	Yes	–	–
Cyperus lucidus	NA	Yes	–	–
Cyperus nutans var. eleusinoides	flatsedge	Yes	–	–
Cyperus pilosus	NA	Yes	–	–
Cyperus polystachyos	NA	Yes	–	–
Cyperus polystachyos var. polystachyos	NA	Yes	–	–
Cyperus procerus	NA	Yes	–	–
Cyperus pygmaeus	dwarf sedge	Yes	–	–
Cyperus scariosus	NA	Yes	–	–

Family *Species Name*	Common Name	Isaac River Sub-Basin[a]	DPM Enviro-sciences[b]	frc environmental[c]
Cyperus squarrosus	bearded flatsedge	Yes	–	–
Eleocharis cylindrostachys	NA	Yes	–	–
Eleocharis dulcis	NA	Yes	Yes	–
Eleocharis pallens	pale spikerush	Yes	Yes	–
Eleocharis philippinensis	NA	Yes	Yes	–
Eleocharis plana	ribbed spikerush	Yes	Yes	–
Fimbristylis microcarya	NA	Yes	–	–
Fimbristylis nuda	NA	Yes	–	–
Fimbristylis nutans	NA	Yes	–	–
Fimbristylis quinquangularis	NA	Yes	–	–
Fimbristylis sieberiana	NA	Yes	–	–
Gahnia sieberiana	sword grass	Yes	–	–
Lipocarpha microcephala	NA	Yes	–	–
Rhynchospora heterochaeta	NA	Yes	–	–
Schoenoplectus subulatus	NA	Yes	–	–
Elatinaceae				
Elatine gratioloides	waterwort	Yes	Yes	–
Haloragaceae				
Myriophyllum verrucosum	water milfoil	Yes	Yes	–
Hydrocharitaceae				
Hydrilla verticillata	hydrilla	Yes		
Ottelia ovalifolia	swamp lily	Yes	Yes	–
Isotetaceae				
Isoetes muelleri	quillwort	Yes	–	–
Junaceae				
Juncus aridicola	tussock rush	Yes	–	–
*Juncus bufonius**	toad rush	Yes	–	–
Juncus subglaucus	NA	Yes	–	–
Juncus usitatus	NA	Yes	Yes	Yes
Juncaginaceae				
Cycnogeton procerus	NA	Yes	–	–
Lythraceae				
Lythrum paradoxum	NA	Yes	–	–
Rotala mexicana	NA	Yes	–	–
Marsileaceae				
Marsilea drummondii	common nardoo	Yes	Yes	–
Marsilea exarata	sway-back nardoo	Yes	–	–
Marsilea hirsuta	hairy nardoo	Yes	Yes	–
Marsilea mutica	shiny nardoo	Yes	Yes	–
Melastomataceae				
Melastoma malabathricum subsp. malabathricum	NA	Yes	–	–
Menyanthaceae				
Nymphoides indica	water snowflake	Yes	–	–

Family *Species Name*	Common Name	Isaac River Sub-Basin[a]	DPM Enviro-sciences[b]	frc environmental[c]
Myrtaceae				
Eucalyptus camaldulensis	NA	Yes	–	–
Lophostemon suaveolens	swamp box	Yes	–	–
Melaleuca bracteata	NA	Yes	–	–
Melaleuca dealbata	swamp tea-tree	Yes	–	–
Melaleuca fluviatilis	NA	Yes	–	–
Melaleuca leucadendra	broad-leaved tea-tree	Yes	–	–
Melaleuca linariifolia	snow-in summer	Yes	–	–
Melaleuca viminalis	NA	Yes	–	–
Najadaceae				
Najas tenuifolia	water nymph	Yes	Yes	–
Nymphaeaceae				
Nymphaea gigantea	NA	Yes	Yes	–
Nymphaea violacea	NA	Yes	–	–
Onagraceae				
Ludwigia octovalvis	willow primrose	Yes	Yes	–
Ludwigia peploides subsp. montevidensis	NA	Yes	Yes	–
Philydraceae				
Philydrum lanuginosum	frogsmouth	Yes	–	–
Phrymaceae				
Glossostigma diandrum	NA	Yes	–	–
Plantaginaceae				
Limnophila brownii	NA	Yes	–	–
Poaceae				
Brachyachne tenella	NA	Yes	–	–
Diplachne fusca var. fusca	NA	Yes	Yes	–
*Echinochloa colona**	awnless barnyard grass	Yes	Yes	–
Elytrophorus spicatus	NA	Yes	–	–
Hemarthria uncinata var. spathacea	NA	Yes	–	–
*Hymenachne amplexicaulis cv. olive***. ***	olive hymenachne	Yes	–	–
Leersia hexandra	swamp rice grass	Yes	–	–
Leptochloa digitata	NA	Yes	Yes	–
Panicum larcomianum	NA	Yes	–	–
Panicum paludosum	swamp panic	Yes	–	–
Pseudoraphis paradoxa	slender mudgrass	Yes	–	–
Pseudoraphis spinescens	spiny mudgrass	Yes	Yes	–
*Urochloa mutica**	NA	Yes	–	–
Walwhalleya subxerophila	NA	Yes	–	–
Polygonaceae				
Duma florulenta	NA	Yes	Yes	–

Family *Species Name*	Common Name	Isaac River Sub-Basin[a]	DPM Enviro-sciences[b]	frc environmental[c]
Persicaria attenuata	NA	Yes	Yes	–
Persicaria barbata	NA	Yes	–	–
Persicaria decipiens	slender knotweed	Yes	Yes	–
Persicaria hydropiper	water pepper	Yes	–	–
Persicaria lapathifolia	pale knotweed	Yes	Yes	–
Persicaria orientalis	princes feathers	Yes	Yes	–
Persicaria prostrata	creeping knotweed	Yes	–	–
Persicaria strigosa	NA	Yes	Yes	–
Pontederiaceae				
Monochoria cyanea	NA	Yes	Yes	–
Potederiaceae				
Potamogeton crispus	curly pondweed	Yes	Yes	–
Potamogeton octandrus	NA	Yes	–	–
Potamogeton tricarinatus	floating pondweed	Yes	–	–
Pteridaceae				
Ceratopteris thalictroides	NA	Yes	–	–
Rubiaceae				
Nauclea orientalis	Leichhardt tree	Yes	–	–
Scrophulariaceae				
Eremophila bignoniiflora	eurah	Yes	–	–
Stylidiaceae				
Stylidium velleioides	NA	Yes	–	–
Typhaceae				
Typha domingensis	NA	Yes	Yes	–
Non-Wetland Indicator Species***				
Amaranthaceae				
Alternanthera denticulata	lesser joyweed	Yes	–	Yes
Cyperaceae				
*Cyperus compressus**	NA	Yes	–	Yes
Cyperus concinnus	NA	Yes	Yes	Yes
Cyperus gracilis	NA	Yes	Yes	–
Cyperus javanicus	NA	Yes	–	Yes
*Cyperus rotundus**	nutgrass	Yes	–	Yes
Cyperus sp.	sedge	–	–	Yes
Cyperus trinervis	NA	Yes	Yes	–
Cyperus victoriensis	NA	Yes	Yes	–
Schoenus sp.	bogrush	Yes	Yes	–
Laxmanniaceae				
Lomandra longifolia	NA	Yes	Yes	–
Lentibulariaceae				
Utricularia sp.	NA	–	Yes	–

Family *Species Name*	Common Name	Isaac River Sub-Basin[a]	DPM Enviro-sciences[b]	frc environmental[c]
Poaceae				
*Chloris virgata**	feathertop rhodes grass	Yes	–	Yes
Eragrostis elongata	NA	–	–	Yes
Polygonaceae	NA			
Polygonum plebeium	small knotweed	Yes	Yes	Yes
Total Number of Wetland Indicators		**108**	**32**	**3**
Other		**12**	**8**	**9**

* indicates introduced species
** indicates restricted noxious pest species under the *Biosecurity Act 2014*
*** included due to known ability to provide aquatic habitat and presence in regional surveys
**** indicates Weed of National Significance
[a] Source: DES 2020e
[b] Source: DPM Enviroscience 2018
[c] Source: frc environmental 2012
NA indicates no common name available

Appendix E Fish Species Recorded from the Region

Table 9.3 Fish recorded from the region

Family *Species Name*	Common Name	Fitzroy River Basin [a]	Isaac River Sub-Basin [a]	DPM Enviro-sciences[b]	frc environmental[c]
Ambassidae					
Ambassis agassizii	Agassiz's glassfish	Yes	Yes	Yes	Yes
Anguillidae					
Anguilla reinhardtii	longfin eel	Yes	Yes	Yes	–
Apogonidae					
Glossamia aprion	mouth almighty	Yes	Yes	–	–
Ariidae					
Neoarius graeffei	blue catfish	Yes	Yes	–	–
Atherinidae					
Craterocephalus marjoriae	silverstreak hardyhead	Yes	–	–	–
Craterocephalus stercusmuscarum	flyspecked hardyhead	Yes	Yes	Yes	–
Belonidae					
Strongylura krefftii	freshwater longtom	Yes	Yes	–	–
Centropomidae					
Lates calcarifer	barramundi	Yes	–	–	–
Ceratodontidae					
Neoceratodus forsteri•••	Australian lungfish	Yes	–	–	–
Cichlidae					
*Oreochromis mossambicus***	mozambique tilapia	Yes [e]	Yes [e]	Yes	–
Clupeidae					
Nematalosa erebi	bony bream	Yes	Yes	Yes	–
Cyprinidae					
*Carassius auratus**	goldfish	Yes	–	–	–
*Cyprinus carpio***	European carp	Yes	–	–	–
Eleotridae					
Gobiomorphus australis	striped gudgeon	Yes	–	–	–
Hypseleotris compressa	empire gudgeon	Yes	Yes	–	–
Hypseleotris galii	firetail gudgeon	Yes	Yes	–	–
Hypseleotris klunzingeri	western carp gudgeon	Yes	Yes	–	–
Hypseleotris spp.	common carp gudgeon	Yes	Yes	Yes	Yes
Mogurnda adspersa	southern purple-spotted gudgeon	Yes	Yes	Yes	Yes
Oxyeleotris aruensis	Aru gudgeon	Yes	Yes	Yes	–
Oxyeleotris lineolata	sleepy cod	Yes	Yes	–	Yes
Philypnodon grandiceps	flathead gudgeon	Yes	Yes	–	–

Family *Species Name*	Common Name	Fitzroy River Basin [a]	Isaac River Sub-Basin [a]	DPM Enviro-sciences [b]	frc environmental [c]
Gobiidae					
Redigobius bikolanus	speckled goby	Yes	–	–	–
Hemiramphidae					
Arrhamphus sclerolepis	snubnose garfish	Yes	Yes	–	–
Megalopidae					
Megalops cyprinoides	oxeye herring	Yes	–	–	–
Melanotaeniidae					
Melanotaenia splendida splendida	eastern rainbowfish	Yes	Yes	Yes	Yes
Rhadinocentrus ornatus	ornate rainbowfish	Yes	–	–	–
Mugilidae					
Mugil cephalus	sea mullet	Yes	–	–	–
Trachystoma petardi	freshwater mullet	Yes	–	–	–
Osteoglossidae					
Scleropages leichardti	southern saratoga	Yes	Yes	–	–
Percichthyidae					
*Maccullochella peelii****	Murray cod	Yes [d]	Yes [d]	–	–
Macquaria ambigua	golden perch	Yes	Yes	Yes	Yes
Plotosidae					
Neosilurus ater	black catfish	Yes	Yes	–	–
Neosilurus hyrtlii	Hyrtl's catfish	Yes	Yes	Yes	Yes
Porochilus rendahli	Rendahl's tandan	Yes	Yes [g]	Yes	–
Tandanus tandanus	freshwater catfish	Yes	Yes	Yes	–
Poeciliidae					
*Gambusia holbrooki***	mosquitofish	Yes [f]	Yes [f]	–	–
*Poecilia reticulata**	guppy	Yes	–	–	–
*Xiphophorus maculatus**	platy	Yes [e]	Yes [e]	–	–
Pseudomugilidae					
Pseudomugil signifer	Pacific blue eye	Yes	Yes	–	–
Retropinnidae					
Retropinna semoni	Australian smelt	Yes [f]	Yes [f]	Yes	–
Scorpaenidae					
Notesthes robusta	bullrout	Yes	–	–	–
Terapontidae					
Amniataba percoides	barred grunter	Yes	Yes	Yes	–
*Bidyanus bidyanus****	silver perch	Yes	Yes	–	–
Hephaestus fuliginosus	sooty grunter	Yes [e]	Yes [e]	–	–
Leiopotherapon unicolor	spangled perch	Yes	Yes	Yes	Yes
Scortum hillii	leathery grunter	Yes	Yes	–	Yes
Terapon jarbua	crescent grunter	Yes	–	–	–
Grand Total		**48**	**33 ******	**16**	**10**

* indicates introduced species

** indicates restricted noxious pest species under the *Biosecurity Act 2014*

*** indicates listed threatened species under the EPBC Act

**** total does not include Murray River cod, as although potential habitat for this species is present according to the EPBC Protected Matters Search Tool from the IAS (Whitehaven, 2019), no confirmed records are available from the catchment

[a] Source: DES 2020e unless specified otherwise

[b] Source: DPM Enviros ciences 2018

[c] Source: frc environmental 2012

[d] Source: no known record available, but potential habitat for this species listed in the EPBC Protected Matters Search Tool from the IAS (Whitehaven WS 2019)

[e] Source: Catchment Solutions 2015

[f] Source: DPM Enviros ciences 2018

[g] Source: URS 2014

Table 9.4 Photographs of fish species caught during the field surveys

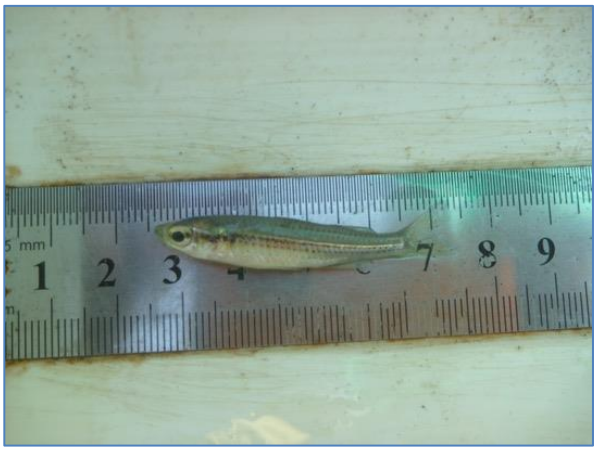
Agassiz's glassfish

Australian smelt

Bony bream

Carp gudgeon

Eastern rainbowfish



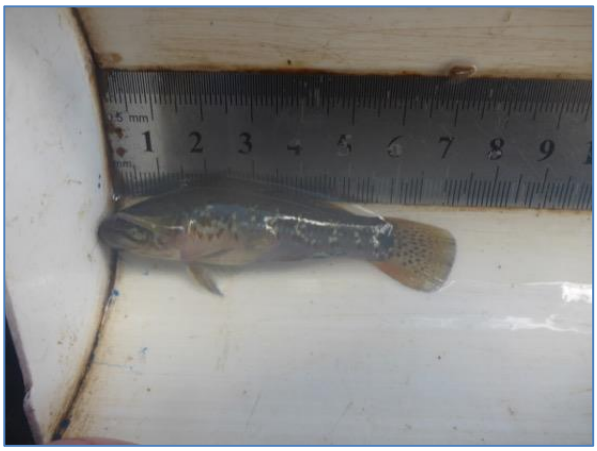
Fly-specked hardyhead

Freshwater catfish

Golden perch

Hyrtl's tandan

Mozambique mouthbrooder / tilapia



Purple-spotted gudgeon

Rendahl's catfish

Sleepy cod

Spangled perch