Appendix 20

Aquatic Ecology Impact Assessment

Byerwen Coal Pty Ltd

Byerwen Coal Project

Aquatic Ecology Impact Assessment

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Revision	Date	Description	Prepared	Reviewed	Approved		
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Item	Page	Section	Comments

** Use after Rev. 0*

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1. DEFINITIONS AND ABBREVIATIONS

The definitions and abbreviations in **Table 1.1** and **Table 1.2,** respectively, apply to this document.

Table 1.1 Definitions

Term	Definition
Critically Endangered	A listing category for individual native species and ecological communities as defined under the EPBC Act. Refer to definition of 'EPBC Act conservation status' for meaning of 'Critically Endangered' under the Act.
'Early wet' season	From October to December, when flow has been established for at least four weeks.
Ecological community	An assemblage of species occupying in a particular area.
Endangered	A listing category as defined under the EPBC Act or NC Act. Refer to definitions of 'EPBC Act conservation status' and 'NC Act conservation status' for meaning of 'Endangered' under each Act.
EPBC Act conservation status	Under the EPBC Act, listed threatened species and ecological communities are assigned a conservation status of either 'Extinct in the Wild', 'Critically Endangered', 'Endangered' or 'Vulnerable'. Definitions for these terms under the EPBC Act are as follows: • Extinct in the Wild: - It is known only to survive in cultivation, in captivity, or as a naturalized population well outside its past range - It has not been recorded in its known and/or expected habitat, at appropriate seasons, anywhere in its past range, despite exhaustive surveys over a time frame appropriate to its life cycle and form. • Critically Endangered: - It is facing an extremely high risk of extinction in the wild in the immediate future, as determined in accordance with the prescribed criteria. • Endangered: - It is not Critically Endangered - It is facing a very high risk of extinction in the wild in the near future, as determined in accordance with the prescribed criteria. • Vulnerable: - It is not Critically Endangered or Endangered - It is facing a high risk of extinction in the wild in the medium-term future, as determined in accordance with the prescribed criteria.
Habitat	An area or areas, permanently, periodically, or occasionally occupied by a species, population, or ecological community, including any and all biotic and abiotic features of the area or areas occupied.
'Late wet' season	From May to July, when watercourses are in a state of recessional base flow, i.e., without significant flood peaks.
Least Concern	Listing category as defined under the NC Act. Refer to definition of NC Act conservation status for meaning of 'Least Concern' under the Act.

Term	Definition
Matters of Environmental Significance	Matters protected under the EPBC Act including, world heritage properties, national heritage properties, wetlands of international importance, listed threatened species and ecological communities, migratory species, Commonwealth marine species, the Great Barrier Reef Marine Park, and nuclear actions (including uranium mines).
Migratory species	Species listed as 'Migratory' under the EPBC Act. Migratory species are those animals that migrate to Australia and its external territories, or, pass through or over Australian waters during their annual migrations. All species on the list of migratory species are matters of national environmental significance under the EPBC Act.
NC Act conservation status	Under the NC Act (and the subordinate *Nature Conservation (Wildlife) Regulation* (Qld) *2006*), protected species are assigned a conservation status of either 'Extinct in the wild', 'Endangered', 'Vulnerable', 'Near Threatened', or 'Least Concern'. Definitions of these terms under the NC Act are as follows: • Extinct in the Wild: - There have been thorough searches conducted for the wildlife, and the wildlife has not been seen in the wild over a period of time appropriate for the life cycle or form of the wildlife. • Endangered: - There have not been thorough searches conducted for the wildlife, and the wildlife has not been seen in the wild over a period that is appropriate for the life cycle or form of the wildlife, or - The habitat, or distribution of the wildlife has been reduced to an extent that the wildlife may be in danger of extinction, or - The population size of the wildlife has declined, or is likely to decline, to an extent that the wildlife may be in danger of extinction, or - The survival of the wildlife in the wild is unlikely if threatening processes continue. • Vulnerable: - Its population is decreasing because of threatening processes, or - Its population has been seriously depleted and its protection is not secured, or - Its population, while abundant, is at risk because of threatening processes, or - Its population is low, localised, or depends on limited habitat that is at risk because of threatening processes. • Near Threatened: - The population size or distribution of the wildlife is small and may become smaller, or - The population size of the wildlife has declined, or is likely to decline, at a rate higher than the usual rate for population changes for the wildlife, or

Term	Definition
	- The survival of the wildlife in the wild is affected to an extent that the wildlife is in danger of becoming vulnerable. • Least Concern: - The wildlife is common, or abundant, and is likely to survive in the wild. Native wildlife may be prescribed as Least Concern wildlife even if: • The wildlife is the subject of a threatening process; or • The population size or distribution of the wildlife has declined; or • There is insufficient information about the wildlife to conclude whether the wildlife is common or abundant or likely to survive in the wild.
Near Threatened	Listing category as defined under the NC Act. Refer to definition of 'NC Act conservation status' for meaning of 'Near Threatened' under the NC Act.
Priority species	Either: • Species listed as 'Critical Priority', 'High Priority', or 'Medium Priority' under the *Back on Track Actions for Biodiversity* in the Burdekin Natural Resource Management Plan (DERM, 2010), or • Species listed under the Aquatic Conservation Assessments, Using AquaBAMM, for the riverine wetlands of the Great Barrier Reef catchment: Burdekin region (Inglis and Howell 2009a). • Species listed under the Aquatic Conservation Assessments, Using AquaBAMM, for the non-riverine wetlands of the Great Barrier Reef catchment: Burdekin region (Inglis and Howell 2009b).
Project area	The project area for this report, which is bounded by the following Mining Lease Application (MLA) areas: • MLA 10355 • MLA 10356 • MLA 10357 • MLA 70434 • MLA 70435 • MLA 70436.
Threatened	A term used for: • Flora and fauna species which have been designated as 'Extinct in the Wild', 'Endangered', or 'Vulnerable' under the NC Act • Flora and fauna species which have been designated as 'Extinct in the Wild', 'Endangered' or 'Vulnerable' under the EPBC Act • 'Ecological Communities' designated as 'Critically Endangered', 'Endangered', or 'Vulnerable' under the EPBC Act • Regional Ecosystems designated as 'Endangered' or 'Of Concern' under the VM Act.
Vulnerable	Listing category as defined under the EPBC Act and/or NC Act. Refer to definitions of 'EPBC Act conservation status' and 'NC Act conservation status' for meaning of 'Vulnerable' under these Acts.

Table 1.2 Abbreviations

Abbreviation	Meaning
ACA(s)	Aquatic Conservation Assessment(s)
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand
ANZECC	Australian and New Zealand Environment Conservation Council
AUSRIVAS	Australian River Assessment System
AquaBAMM	Aquatic Biodiversity Assessment and Mapping Methodology
CE	Critically Endangered
CHPP	Coal Handling and Preparation Plant
CoC	Chain of Custody
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DEHP	Queensland Department of Environment and Heritage Protection
DERM	(Former) Queensland Department of Environment and Resource Management
DEWHA	(Former) Commonwealth Department of the Environment, Water, Heritage and the Arts
DMP	Damage Mitigation Permit
DNRM	(Former) Queensland Department of Natural Resources and Mines
DSEWPaC	Commonwealth Department of Sustainability, Environment, Water, Population and Communities
E	Endangered
EA	Environmental Authority
EIA	Environmental Impact Assessment
EIS	Environmental Impact Statement
EMP	Environmental Management Plan
EP Act	*Queensland Environmental Protection Act 1994*
EPA	Environmental Protection Agency
EPBC Act	*Commonwealth Environment Protection and Biodiversity Conservation Act 1999*
EPT	Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddis flies)
ERA	Environmentally Relevant Activity
ESA, ESAs	Environmentally Sensitive Area(s)
ESD	Ecologically Sustainable Development
et al.	Shortened version of the Latin `*et alii*' (masculine plural) or `*et aliae*' (feminine plural) or `*et alia*' (neuter plural) (and others)
EVNT	'Endangered, Vulnerable or Near Threatened' under the NC Act or 'Critically Endangered, Endangered, Vulnerable or Conservation Dependent' under the EPBC Act
GPS	Global Positioning System

Abbreviation	Meaning
ha	Hectare(s)
HES	High Ecological Significance
i.e.	Latin for '*id est*' (that is)
km	Kilometre(s)
km^2	Square kilometre(s)
Lat.	Latitude
LC	Least Concern
Long.	Longitude
LP Act	*Queensland Land Protection (Pest and Stock Route Management) Act 2002*
m	Metre(s)
Mi	Migratory
MIA	Mine Infrastructure Area (northern = NMIA; and southern = SMIA)
ML	Mining Lease
MLA	Mining Lease Application
MNES	Matters of National Environmental Significance
N/A	'Not applicable' or 'not available'
NATA	National Association of Testing Authorities
NC Act	*Queensland Nature Conservation Act 1992*
NR	Not Recorded
NRM	Natural Resource Management
NT	Near Threatened
OC	Of Concern
Qld	Queensland
QWQG	Queensland Water Quality Guidelines
RE	Regional Ecosystem
REMP	Receiving Environment Monitoring Program
ROM	Run of Mine
RPP	Riverine Protection Permit
R&T	Rare and Threatened
SIGNAL	Stream Invertebrate Grade Number Average Level
SMP	Species Management Program
SP Act	*Queensland Sustainable Planning Act 2009*
sp.	Species (singular)
spp.	Species (plural)
SPP	*State Planning Policy*
subsp.	Subspecies
SDPWO Act	*State Development and Public Works Organisation Act 1971*

Abbreviation	Meaning
ToR	Terms of Reference
TSSC	Threatened Species Scientific Committee
V	Vulnerable
WoNS	Weeds of National Significance
WMA	Wetland Management Areas
WPA	Wetland Protection Areas

2. EXECUTIVE SUMMARY

AMEC Environment & Infrastructure Pty Ltd was commissioned by Byerwen Coal Pty Ltd to undertake an aquatic ecology impact assessment for the proposed Byerwen Coal project. The Byerwen Coal project (the Project) involves the development of an integrated project, with a multiple pit open-cut coal mine and associated infrastructure. The assessment was based on desktop information on the broader catchments in which the Project is located, for the open cut first stage, with a "late wet season" field survey being undertaken between 1 and 6 May 2012.

The project area is located across (straddles) the Suttor River and Bowen River catchments, which are both part of the headwaters of the broader Burdekin River catchment. Within the Suttor River and Bowen River catchments are sub-catchments; specifically the project area lies across the Rosella Creek sub-catchment (part of the Bowen River catchment to the north, and the Upper Suttor River sub-catchment to the south.

Field surveys were undertaken at ten sites within the Project area in order to characterise representative aquatic habitats and biota within the Project area. Three sites were located in confirmed watercourses[1] (it should be noted that DEHP Mapping shows only two watercourses within the Project area), four sites were located in drainage lines[2] one site was located in gilgai, one site within a lacustrine wetland and one site was located in a palustrine wetland.

Site and desktop investigations suggest that watercourses and drainage lines transecting the project area incur flow intermittently and are likely characterised by high inter-annual flow variability. The palustrine and gilgai wetlands are likely to contain water intermittently in the wet season. The lacustrine wetland would be classified as semi-permanent. The wetlands, waterways, and associated riparian corridors within, and adjoining the project area provide both aquatic and terrestrial species with opportunities for refuge, foraging, nesting, and breeding habitat.

The Project will have both direct and indirect impacts on the aquatic values of Kangaroo Creek and its tributaries, and both direct and indirect impacts on tributaries of the Suttor River. Direct impacts are focussed on the removal of approximately 36.2 km of riverine habitat, including approximately 18.6 km of riverine habitat in the Rosella Creek sub-catchment and 17.6 km of riverine habitat in the Suttor River catchment. These impacts are deemed to be short and medium term, generally confined to the life of the Project.

No aquatic 'Threatened Ecological Communities' have been detected in the project area, nor are any expected to occur.

No wetlands of international significance (Ramsar wetlands) or wetlands of national importance are present on the site.

[1] Drainage features within the project area shown on the Queensland Wetlands Map 2009 which have been confirmed by Department of Environment and Heritage Protection (DEHP) to be watercourses under the *Water Act 2000* (source: data provided to KBR in correspondence dated 19 July 2012). These features will herein be consistently referred to as watercourses, as distinct from the remaining drainage features which will be referred to as drainage lines.

[2] Drainage features shown on the Queensland Wetland Map 2009 which have not been defined as watercourses by DEHP. These features will herein be consistently referred to as drainage lines.

The Project will remove two mapped lacustrine wetlands totalling approximately 5.8 ha in area. These impacts would be permanent.

No 'Endangered', 'Vulnerable' or 'Near Threatened' aquatic flora species are likely to occur within the Project area. However, a palustrine wetland of high ecological significance, supporting a number of Priority flora species, occurs on the western boundary of the Project area. The catchment of this wetland would be reduced by approximately 43% for a period of 16 years. Post closure, the remediation strategy for the area will include returning the land to a similar hydrological profile, creating a similar catchment for the wetland. It is anticipated that there will be some alteration in plant species composition over time as hydrological conditions change. A return to pre-disturbance hydrological regimes is considered likely to be accompanied by a shift back to the existing floristic and structural composition.

Macroinvertebrate and fish sampling was undertaken in representative habitats where adequate water was encountered. Macroinvertebrate communities sampled in the 'late wet' season of 2012 were largely dominated by pollution and disturbance tolerant taxa. Data analysis suggests that most aquatic survey sites had been under long-term stress from decreasing water quality (possibly natural or from past and present land uses), harsh physical conditions (intense seasonal runoff and erosion and deposition of fine sediments), or other existing anthropogenic effects.

Fish surveys identified eight species of fish, all of which were native. No EVNT or 'Special Least Concern' (platypus) aquatic fauna species, were recorded, or are likely to occur within the Project area. A number of Priority fish species are either known to occur, or may occur, within the watercourses and drainage lines transecting the Project area. However, both direct and indirect impacts on these species through habitat modification are deemed to be short term and confined to the establishment phase of the Project. Direct impacts can be reduced by relocating isolated fish in accordance with a General Fisheries Permit where de-watering of water bodies is undertaken.

Freshwater turtles are likely to occur within lacustrine wetlands and semi-permanent pools on watercourses. Turtles would need to be relocated from dewatered areas in accordance with a Species Management Program (SMP) or Damage Mitigation Permit (DMP).

Cumulative impacts within the broader Burdekin River catchment are expected to be minimal.

Provided that the mitigation measures outlined in this report are implemented effectively, development of the Project is unlikely to result in a significant impact on threatened or Priority aquatic species, aquatic ecological communities, or their habitats. The ecological integrity of the Suttor River, Rosella Creek or their downstream receiving environs, is unlikely to be significantly impacted the Project.

3. INTRODUCTION

AMEC Environment & Infrastructure Australia Pty Ltd (AMEC) was commissioned by Byerwen Coal Pty Ltd (Byerwen Coal) to undertake an aquatic ecology impact assessment for the proposed Byerwen Coal Project (the Project). The Project involves the development of an integrated multiple pit open-cut coal mine and associated infrastructure.

This report describes the aquatic ecological values of the region in which the mine is proposed, assesses the potential impacts that may arise during construction, operation, and decommissioning of the Project, and recommends management strategies to avoid or minimise these impacts. Results discussed in this report are based on a desktop assessment of information available from the project area, and a field survey undertaken from 1 to 6 May 2012. The report has also considered the findings and recommendations of KBR (2012a); KBR (2012b); and KBR (2012c). The Project area, including survey sites, is presented in **Figure 3.1**.

3.1 PURPOSE

This technical report addresses the Terms of Reference (ToR) for the Project relevant to aquatic ecology, and provides information for input into the Byerwen Coal Project Environmental Impact Statement (EIS).

The overall objective of this report is to discuss the aquatic ecological values of areas that may be impacted by the Project, and identify mitigation measures that may be implemented to avoid or minimise potential impacts on ecological values.

More specifically, this report identifies and describes palustrine, lacustrine, and riverine systems, located within, and in proximity to, the project area. This report also addresses the potential and known occurrences of protected aquatic plants and animals, identified under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), the Queensland *Nature Conservation Act 1992* (NC Act), and relevant subordinate legislation.

Furthermore, this report considers potential impacts on Priority species, as identified by DERM (2010) and Inglis and Howell (2009a, 2009b). Aquatic weed species listed under the Queensland *Land Protection (Pest and Stock Route Management) Act 2002* (LP Act) and Commonwealth Weeds of National Significance (WoNS) database are also considered and discussed. Where relevant, general biodiversity values, evaluated in terms of 'Least Concern' aquatic flora and fauna, were also considered.

3.2 SCOPE OF WORKS

This report specifically addresses Section 3.3.4, Aquatic Biology, of the ToR for the Project's EIS. **Table 3.1** lists these ToR requirements and references the relevant sections of this report where the requirements are addressed. This report also considers general requirements under Sections 3, 3.3, 3.3.1 and 3.4 of the ToR.

Table 3.1 Terms of Reference Requirement

Terms of Reference - Section 3.3.4	Reference in this Report Other Documents
Description of Environmental Values The aquatic flora and fauna occurring in the areas affected by the proposal should be described, noting the patterns and distribution in the waterways and any associated wetlands. The description of the flora and fauna present or likely to be present in the area should include (where applicable):	
• Fish species, mammals, reptiles, amphibians, crustaceans and aquatic invertebrates occurring in the waterways within the affected area and any associated wetlands	**Sections 7.1**, **7.2**, **7.4** and **7.5**. Amphibians are discussed in **Section 7.2.2**, **7.2.3** and **7.2.4** of the Byerwen Coal Project Terrestrial Ecology Impact Assessment (AMEC 2012).
• Any rare or threatened marine species	Not applicable
• A description of the habitat requirements and the sensitivity of aquatic species to changes in flow regime, water levels and water quality in the project area	**Sections 7.1.3** and **7.1.4**
• Aquatic plants including native and exotic/weed species	**Sections 7.1.3** and **7.4**
• Aquatic and benthic substrate	**Section 7.2.5** and **Appendix B**
• Habitat downstream of the Project or, potentially impacted due to currents in associated lacustrine (living in or growing in lakes) and marine environments	**Sections 4.2** and **7.2.1**
• Aquatic substrate and stream type, including, extent of tidal influence and common levels such as highest astronomical tide and mean high water springs.	**Section 7.2** and **Appendix B**
Potential Impacts and Mitigation Measures Discuss the potential impacts of the Project on the aquatic ecosystems and describe proposed mitigation actions, including:	
• Details of proposed stream diversions, causeway construction and crossing facilities, stockpiled material and other impediments that would restrict free movement of aquatic fauna	**Sections** □ and **8.1.5**
• Measures to avoid fish spawning periods, such as seasonal construction of waterway crossings, and measures to facilitate fish movements through water crossings	**Section 8.1.5**
• Details of alternatives to waterway crossings where possible	**Section 8.1.5**
• Offsets proposed for unavoidable, permanent loss of fisheries habitat	Refer to the Offsets Management Plan

Terms of Reference - Section 3.3.4	Reference in this Report Other Documents
• A description of methods to minimise the potential for the introduction and/or spread of weed species or plant disease	This assessment has found a low occurrence of aquatic weeds. Field surveys did not detect any aquatic weeds of national significance or weeds declared under relevant state legislation (**Section 7.4**). **Section 8.1.5** stipulates a requirement for weed control in disturbed areas, to minimise the potential for the introduction and/or spread of weed species. Methods to minimise the potential for introduction and/or spread of weed species or plant disease in general are provided in the Byerwen Coal Project Terrestrial Ecology Impact Assessment (AMEC 2012).
• Details of monitoring of aquatic biology health, productivity and biodiversity in areas subject to direct discharge	A Receiving Environment Monitoring Program (REMP) will be developed for the Project. The intent of the REMP will be to provide aquatic condition assessment in local areas potentially affected by mine water releases. The REMP will be developed and implemented to monitor and record the effects of the release of contaminants on the receiving environment periodically and whilst contaminants are being discharged from the site.
• Address any actions of the project of likely impacts that require an authority under the relevant legislation including the NC Act and/or the *Fisheries Act 1994* (Fisheries Act). Outline how these measures will be implemented in the overall EMP for the Project.	**Sections** □ and **8.1.2**

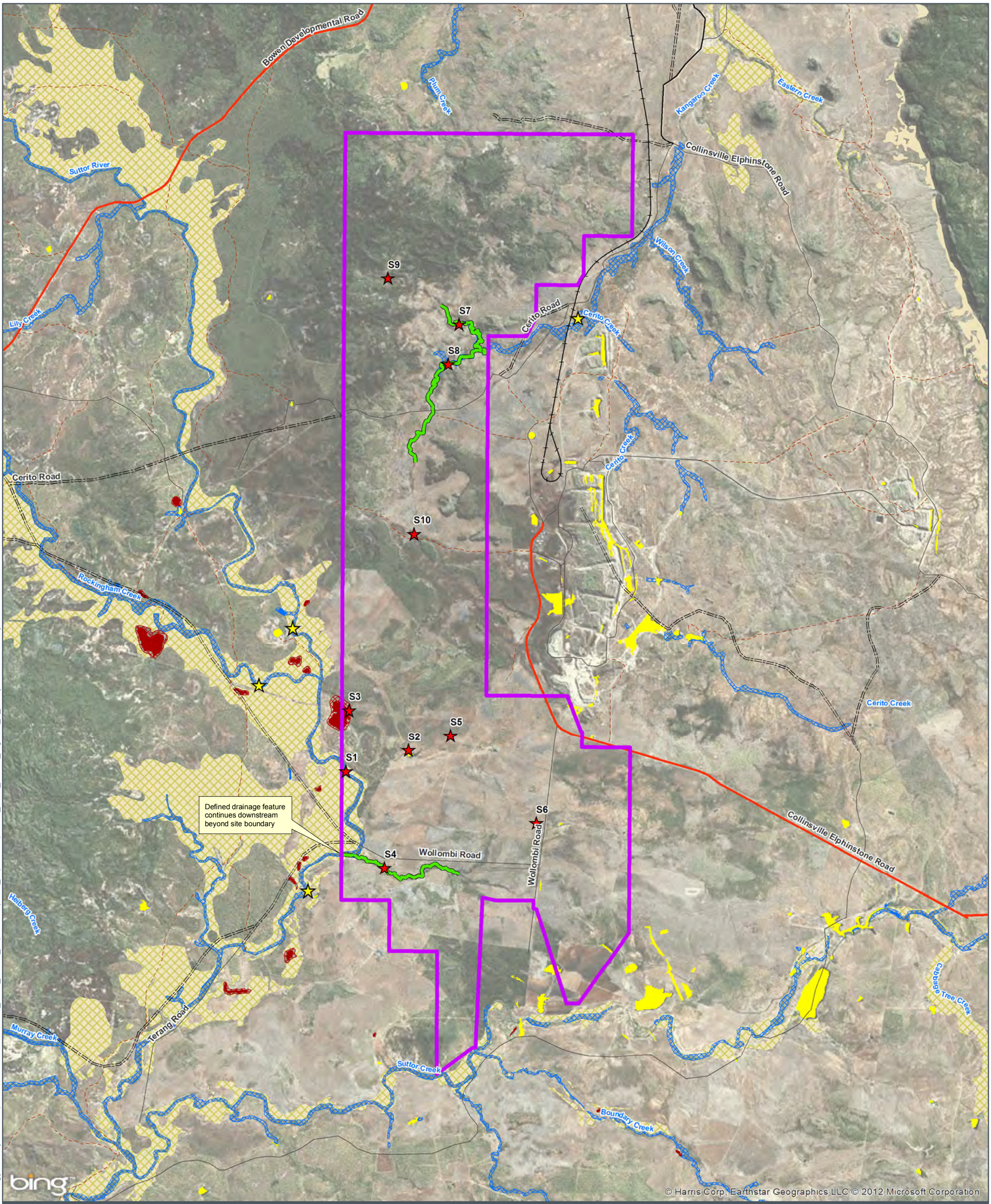
3.3 ASSUMPTIONS AND LIMITATIONS

The information presented in this report is subject to the following assumptions and limitations:

- This report includes results from one field survey, and therefore does not account for seasonal variability in aquatic values.
- Sampling was conducted in May ('late wet' season), approximately 6 weeks after a flood event in the area, during which the Suttor River rose approximately 7 m in 24 hours (**Section 7.2.1**). Limitations of results are discussed in **Section 7.2.1**. A further 'early wet' season survey was undertaken between 11 and 15December 2012, the results of which were not yet available at the time of the report.
- Some of the databases used to obtain information for this report have caveats regarding the robustness or completeness of the data they contain (i.e., WetlandInfo derived from the DEHP WildNet database). For example, WildNet data are based only on recorded sightings of wildlife, and therefore the absence of a recorded sighting of a species in an area does not necessarily imply that the species does not occur in that area.
- Similarly, data from the Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC), EPBC Act Protected Matters Search,

are based on a combination of actual records, primarily from State Government databases, and modelled distributions of species according to their ecological characteristics. The lists of species and communities generated by this search should be considered indicative only, and site surveys are required to confirm their presence or absence.

- Due to access constraints, some aquatic survey sites selected in the desktop assessment were unable to be assessed. Replacement sites which captured relevant catchment characteristics were therefore chosen in accessible locations. The establishment of appropriate monitoring locations as part of a REMP and the subsequent collection of baseline data for biological indicators is suggested for the locations included in **Figure 3.1**.
- A separate specialist report on stygofauna has been prepared for the project and stygofauna are not assessed in this report.



Byerwen Coal - BYC002 Impact Footprint

LEGEND

LOCATION DIAGRAM

Figure 3.1 - Project Area and Survey Sites

Aquatic Survey Site
REMP Survey Site
Rail

Road Network
Highway
Main Road
Secondary Road
Local Road
Vehicular Track
Proposed Road
Unconstructed Road
Confirmed Watercourse (DEHP 2012)
MLA Boundary

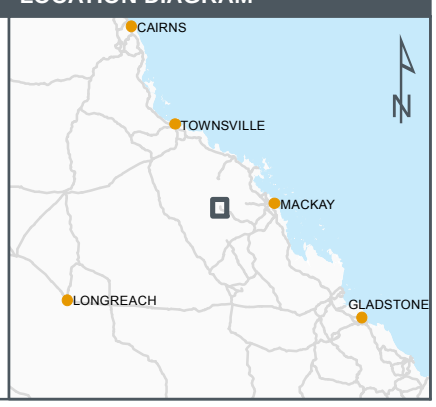
Water Bodies and Wetland RE
Riverine Water Bodies
Lacustrine Water Bodies
Palustrine Water Bodies
Riverine Wetland RE
Palustrine Wetland RE
Remnant RE 51-80% Wetland (mosaic units)
Remnant RE 1-50% Wetland (mosaic units)

amec

0 1 2 3
Kilometres

1:125,000

(A3) GDA 1994 MGA Zone 55



WORK REQUEST NUMBER: WR_2012_00291

DATA SOURCES:
Wetland Info V3 © State of Queensland 2011
Physical Road Network © State of Queensland 2010
Physical Rail Network © State of Queensland 2010
Remnant Watercourses © State of Queensland 2011
Bing © MapData Sciences Australia 2010

DATE	AUTHOR	APPROVED	REVISION NOTE	REV.
27/09/2012	AB/SN	JC	Issued for Review	A
19/12/2012	AB	JC	Issued for Review	B
20/12/2012	AB	JC	Issued for Use	0

Path: P:\Clients - Projects\Byerwen Coal\BYC002-Ecology Surveys and Impact Assessment\GIS\WR_2012_00291_ImpactFootprints_AquaticMaps\WR_2012_00291_Figure3_1_StudyAreaAndSurveySites.mxd

4. BACKGROUND

4.1 PROJECT DESCRIPTION

The Project involves the development of an integrated open-cut coal mine, located in the Northern Bowen basin, approximately 20 km west of Glenden and 140 km west of Mackay. The proponent is Byerwen Coal, a joint venture between QCoal Pty Ltd and JFE Steel.

The mine and associated infrastructure would be developed over six mining lease application (MLA) areas totalling approximately 22,697 ha adjacent to the existing Newlands coal mine.

The proposed life of the Project is 50 years, which includes the construction, operation and decommissioning phases. Open-cut mining is proposed to extract the coal, involving the use of conventional excavators and trucks, in combination with electric rope shovels and dragline. Mining activities would be carried out 24 hours a day, 7 days per week, for 52 weeks per year.

The proposed mine layout and associated infrastructure is shown in **Figure 4.1**. The project as assessed in this report includes:

- Progressive development of several open cut pits. The North and West Pits form single footprints while the South and East Pits are split. For the purposes of this impact assessment, six separate pit footprints are discussed – the North Pit, West Pit (comprising West Pit 1, West Pit 2 and West Pit 3), South Pit 1, South Pit 2, East Pit 1 and East Pit 2.
- Spoil placement areas external to the pits will be used for placement of overburden material from initial box cuts.
- A Northern Infrastructure Area servicing the North Pit, comprising a coal handling and processing plant (CHPP) and mine infrastructure area (MIA), associated run-of-mine (ROM) and product coal stockpiles, raw water storage, tailings and reject co-disposal areas, various roads and conveyors. This area also includes rail load out facilities and a rail loop connecting to the Goonyella to Abbott Point (GAP) rail line.
- A Southern Infrastructure Area servicing the remaining open cut pits, comprising a separate CHPP and MIA, associated ROM and product coal stockpiles, raw water storage, co-disposal areas, roads, conveyors, a separate rail load out facility and rail loop connecting to the GAP rail line.
- A proposed 60 m wide central infrastructure corridor connecting the Northern and Southern Infrastructure Areas, including road, water supply pipeline, power supply and crossings across tributaries of Kangaroo Creek.
- Access roads and internal haul roads connecting the pits and MIA.
- Diversions of existing creek lines (two tributaries of the Suttor River and a tributary of Kangaroo Creek).
- Diversions of existing power infrastructure.
- Mine water management infrastructure, including environmental dams and associated pipelines.

The direct footprint of all infrastructure provided by QCoal has been buffered so that any additional areas that will be isolated or cleared as a result of mining and/or associated infrastructure (e.g. non-viable linear corridors between haul roads and pits) are included within the impact footprint.

The assessment excludes consideration of the potential impacts associated with a separate underground mine in the far north of the study area, and associated subsidence-related impacts.

4.2 PROJECT AREA AND PROJECT FOOTPRINT

For the purpose of the Byerwen Coal EIS, and this Aquatic Ecology Impact Assessment, the project area is defined by the boundaries of the following Mining Lease Application (MLA) areas:

- MLA 10355
- MLA 10356
- MLA 10357
- MLA 70434
- MLA 70435
- MLA 70436.

The project area is wholly within the Burdekin River catchment. The northern section and most of the central sections of the project area are within the Bowen River sub-catchment and are drained by Plum Creek, Kangaroo Creek, and their respective tributaries. The southern section of the project area falls within the Suttor River sub-catchment and is drained by the Suttor River and its tributaries (**Figure 4.1**).

The project disturbance footprint is shown in **Figure 4.2**. It is expected that above ground infrastructure and mining activities will have a total disturbance area of approximately 7,482 ha. It should be noted that this is a conservative calculation and is likely to overestimate actual impact in some areas. Approximately 36.2 km of natural streams (watercourses and drainage lines) and approximately 5.8 ha of lacustrine wetlands will be directly impacted (**Section 8.1**). Five stream diversions will be required, four diversions in the Upper Suttor River catchment and one in the Kangaroo Creek catchment (**Section 8.1.1**). Mine-affected water would be contained on site in dams for periods of time until there is sufficient dilution to allow release to the environment and still achieve water quality objectives (**Section 8.2.1**). This understanding of the Project has been used to assess the scale of impact that the Project may have on the ecological values of the project area.

Bowen Developmental Road
Plum Creek
Kangaroo Creek
Eastern Creek
Collinsville Elphinstone Road
Suttor River
Lily Creek
North Pit 1
Spoil
Cerito Road
Cerito Creek
Cerito Creek
Wilson Creek
NEWLANDS MINING LEASE
Cerito Road
Rockingham Creek
West Pit 3
West Pit 2
Spoil
Cerito Creek
West Pit 1
Spoil
East Pit 1
Spoil
Spoil
South Pit 1
Wollombi Road
Wollombi Road
East Pit 2
Collinsville Elphinstone Road
Spoil
Heiberg Creek
Spoil
South Pit 2
Terang Road
Murray Creek
Suttor Creek
Boundary Creek
bing
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Byerwen Coal - BYC002 Impact Footprint

Figure 4.1 - Proposed Mine Layout

WORK REQUEST NUMBER: WR_2012_00291

DATA SOURCES:
Physical Road Network © State of Queensland 2010
Remnant Watercourses © State of Queensland 2011
Wetland Info V3 © State of Queensland 2011
Mining Leases © State of Queensland 2011

LEGEND

- Powerline Diversion
- Creek Diversion
- Main Road
- Secondary Road
- Local Road
- Vehicular Track
- Unconstructed Road
- Railway
- Drainage Feature
- MLA Boundary
- Newlands Mining Lease
- Haul Road
- Powerline Diversion
- Creek Diversion
- Dam
- Pit
- Impact Footprint
- Infrastructure Area

Water Bodies and Wetland RE
- Riverine Water Bodies
- Lacustrine Water Bodies
- Palustrine Water Bodies
- Riverine Wetland RE
- Palustrine Wetland RE
- Remnant RE 51-80% Wetland (mosaic units)
- Remnant RE 1-50% Wetland (mosaic units)

DATE	AUTHOR	APPROVED	REVISION NOTE	REV.
27/09/2012	AB	JC	Issued for Review	A
19/12/2012	AB	JC	Issued for Review	B
20/12/2012	AB	JC	Issued for Use	0

amec

0 1 2 3
Kilometres

1:125,000

(A3) GCS GDA 1994

LOCATION DIAGRAM

BOWEN
MACKAY
LLANARTH
N

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Bowen Developmental Road
Plum Creek
Kangaroo Creek
Eastern Creek
Collinsville Elphinstone Road
Suttor River
Lily Creek
Cerito Road
Cerito Creek
Wilson Creek
Rockingham Creek
Wollombi Road
Heiberg Creek
Terang Road
Murray Creek
Suttor Creek
Boundary Creek
bing
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Byerwen Coal - BYC002 Impact Footprint

Figure 4.2 - Areas of Project Disturbance

WORK REQUEST NUMBER: WR_2012_00291

DATA SOURCES:
Physical Road Network © State of Queensland 2010
Remnant Watercourses © State of Queensland 2011
Wetland Info V3 © State of Queensland 2011
Mining Leases © State of Queensland 2011

LEGEND

- Railway
- Main Road
- Secondary Road
- Local Road
- Vehicular Track
- Unconstructed Road
- Drainage Feature
- MLA Boundary
- Disturbance Footprint

Water Bodies and Wetland RE

- Riverine Water Bodies
- Lacustrine Water Bodies
- Palustrine Water Bodies
- Riverine Wetland RE
- Palustrine Wetland RE
- Remnant RE 51-80% Wetland (mosaic units)
- Remnant RE 1-50% Wetland (mosaic units)

DATE	AUTHOR	APPROVED	REVISION NOTE	REV.
21/09/2012	AB	JC	Issued for Review	A
19/12/2012	AB	JC	Issued for Review	B
20/12/2012	AB	JC	Issued for Use	0

amec

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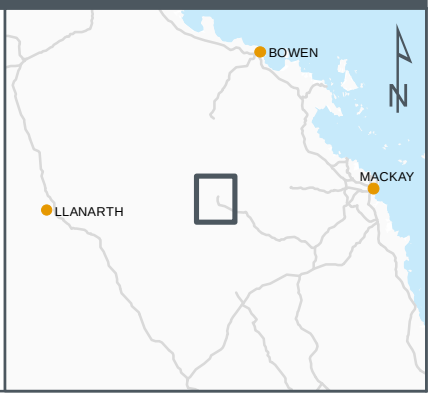
Kilometres
1:125,000
(A3) GCS GDA 1994

LOCATION DIAGRAM



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5. LEGISLATIVE FRAMEWORK AND RELEVANT GUIDELINES

The following section provides an outline of legislation, policy and guidelines relevant to the identification and management of aquatic ecological values within the project area.

5.1 COMMONWEALTH LEGISLATION

5.1.1 *Environment Protection and Biodiversity Conservation Act 1999*

The EPBC Act is administered by the DSEWPaC and regulates any action that will, or is likely to, have an impact on any Matter of National Environmental Significance (MNES) including:

- World heritage places
- National heritage places
- Wetlands of international significance (Ramsar wetlands)
- Threatened species and ecological communities
- Migratory species protected under international agreements
- Commonwealth marine areas
- The Great Barrier Reef Marine Park
- Nuclear actions.

Other matters that may trigger DSEWPaC jurisdiction include:

- Actions that are located within, or will affect, Commonwealth lands
- Actions where Commonwealth agencies are proposing to undertake the action.

Pursuant to the EPBC Act a person must not undertake any action that will have, or is likely to have, a significant impact on any MNES. According to the EPBC Act Policy Statement 1.1 - Significant Impact Guidelines (DEWHA 2009), a significant impact is an impact which is important, notable or of consequence, having regard to its context or intensity. The likelihood of an action having a significant impact depends upon the intensity, duration, magnitude, and geographic extent of the impacts. A significant impact is considered likely if it is a real or does not have a remote chance or possibility.

Based on the referral submitted to DSEWPaC on 14 December 2010, the Project was deemed a controlled action. The relevant controlling provisions, as listed in the decision referral notice, include listed threatened species and communities, and listed migratory species. The Project is to be assessed under the bilateral agreement between the Commonwealth and Queensland.

DSEWPaC has issued a referral decision (2010/5778) noting that the project is a controlled action, requiring assessment and approval under the EPBC Act. The relevant controlling provisions were identified as *Listed threatened species and communities*; and *Listed migratory species*. Wetlands of international significance were not identified as a controlling provision. This aquatic ecology impact assessment has found that the project is unlikely to cause a significant impact[3] on aquatic species, communities or features identified as MNES. Impacts on MNES have been specifically considered in the Byerwen

[3] The assessment of significance has been made with reference to the EPBC Act Significant Impact Guidelines 1.1 (DEWHA 2009).

Coal Project - Matters of National Environmental Significance Assessment Report (BYC002-ENV-RPT-0002).

5.2 STATE LEGISLATION

5.2.1 *Environmental Protection Act 1994*

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

5.2.2 *Nature Conservation Act 1992*

The *Nature Conservation Act 1992* (NC Act) deals with the legal status and management of certain flora and fauna species listed under the *Nature Conservation (Wildlife) Regulation 2006* and the *Nature Conservation (Wildlife Management) Regulation 2006*. It prohibits the destruction or removal, unless authorised, of native flora and fauna species in the wild. The NC Act also provides an integrated and comprehensive strategy for conserving nature. It provides a legislative basis for research, community education, dedicating, declaring, and managing protected areas, protecting native wildlife and its habitat, and the cooperative involvement of landholders in the conservation of nature. The Department of Environment and Heritage Protection (DEHP) is the administering authority for the wildlife provisions within the NC Act.

Chapter 7 of the *Nature Conservation (Wildlife Management) Regulation 2006* establishes offenses relating to wildlife. Under Section 332, it is an offense to remove or tamper with an animal breeding place that is being used by a protected animal to incubate or rear the animal's offspring, without reasonable excuse. The offense does not arise where the removal or tampering of an animal's breeding place is part of an approved Species Management Program (SMP) for animals of the same species, or if the person holds a Damage Mitigation Permit (DMP) for the animal and the permit authorises the removal or tampering.

In the event that project activities may disturb any animal breeding places, or breeding habitat, it would be necessary for approval to be obtained from the DEHP before these activities were undertaken. Approval would need to be supported by a SMP or DMP, which contains a set of standard procedures designed to minimise the impact of the activities.

'Breeding habitat' is defined in Section 332 (2) of the *Nature Conservation (Wildlife Management) Regulation 2006* as, a place being used by a protected animal to incubate or rear the animal's offspring if:

- The animal is preparing, or has prepared, the place for incubating or rearing the animal's offspring, or
- The animal is breeding, or is about to breed, and is physically occupying the place, or
- The animal and the animal's offspring are physically occupying the place, even if the occupation is only periodical, or
- The animal has used the place to incubate or rear the animal's offspring and is of a species generally known to return to the place to incubate or rear offspring in each breeding season for the animal.

The Project would also need to apply for a generic exemption from the provision in the NC Act that restricts the taking of "Least Concern" plant species. This exemption would need to be obtained prior to the clearing of any native vegetation.

5.2.3 *Fisheries Act 1994*

The Fisheries Act is, 'an Act for the management, use, development, and protection of fisheries resources and fish habitats…'. The main purpose of the Fisheries Act is to provide for the use, conservation, and enhancement of the community's fisheries resources and fish habitats, by applying the principles of ESD.

The Fisheries Act incorporates fish passage, and provides legislation to manage developments that may impact on fish passage through activities such as construction of a waterway barrier. The Fisheries Act defines waterway barrier works as a dam, weir, or other barrier across a waterway, if the barrier limits fish stock access and movement along a waterway.

Mining activities authorized under the *Mineral Resources Act 1989* are exempt from requirements under the *Sustainable Planning Act 2009*, including the requirements for obtaining waterway barrier works development approvals. Impacts of exempt waterway barrier works associated with the mining activity on fish movement are managed through conditions imposed in the Environmental Authority.

Assessments of the impact on fish passage, and any subsequent need for fishways, will be made during the detailed design stage for stream diversions and stream crossings. This is an iterative process between biologists and engineers to ensure that waterway barriers are designed to facilitate fish passage where required, such as by ensuring design velocities allow for fish passage during low flow conditions and that structures provide relevant drown-out characteristics for high flow events.

5.2.4 *Water Act 2000*

The *Water Act 2000* provides for the sustainable management of water and other resources, the establishment and operation of water authorities, and for other purposes. Any potential works that will destroy vegetation, excavate, or place fill within a watercourse, lake or spring, will require a Riverine Protection Permit (RPP). Mining operations may be exempt from obtaining a RPP, providing works are in accordance with the *Guideline – activities in a watercourse, lake or spring associated with mining*

operations (DERM 2010). If works are not consistent with the guideline, a RPP would be required.

A watercourse is defined as a river, creek, or stream in which water flows permanently or intermittently, and includes the bed and banks and any other element of a river, creek or stream confining or containing water. DEHP has made an assessment of drainage features within the project area which meet the definition of a watercourse for the purpose of assessment under the Water Act. These watercourses are shown in **Figure 4.1**. The remaining drainage features are simply defined as drainage lines, and are exempt from assessment under the Water Act.

Waterway diversions and related assessments under the *Water Act 2000* will be addressed in a Diversion Management Plan.

5.2.5 *Land Protection (Pest and Stock Route Management) Act 2002*

The *Land Protection (Pest and Stock Route Management) Act 2002* (LP Act) provides for the management of pests on land, and the management of the stock route network.

Of relevance to this Project, the LP Act provides a framework to manage pests and address their environmental impacts. Under this Act, pests are declared according to three categories, each with varying obligations for control.

This Act also sets up the framework for the preparation and implementation of Local Government Pest Management Plans. These plans identify pest species of significance to a Local Government Area, and outline strategies to manage these species.

5.3 STATE PLANNING POLICY

A State Planning Policy (SPP) is an instrument put in place for matters of state interest that are required to be considered by the administering authority for any development applications lodged under the *Sustainable Planning Act 2009* (SP Act).

The project area falls within the Great Barrier Reef (GBR) catchment and is therefore subject to SPP 4/11 – *Protecting Wetlands of High Ecological Significance in Great Barrier Reef Catchments*. SPP 4/11 aims to prevent the loss or degradation of wetlands and their environmental values, or enhance these values through the appropriate planning, designing, and constructing of development in or adjacent to wetlands of High Ecological Significance (HES) in GBR catchments.

The SP Act is not relevant to the Project and as a result the SPP does not apply directly. However, the principles outlined in this SPP have been considered in the environmental impacts of the Project.

5.4 RELEVANT GUIDELINES

5.4.1 Water Quality Guidelines

The *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZECC/ARMCANZ, 2000), are the default water quality guidelines for aquatic ecosystems in Australia. Physico-chemical water quality measurements were obtained and water samples were collected and analysed as part of the aquatic habitat assessment at study sites (**Section 6.3.3**). The data were interpreted by comparison to these guidelines using:

- Default trigger values for physical and chemical stressors for tropical Australia for slightly disturbed ecosystems
- Default trigger values for toxicants at 95% species protection level – slightly to moderately disturbed freshwater systems.

The ANZECC/ARMCANZ guidelines also recommend that, where individual states or territories have developed their own regional guideline trigger values, those should be used in preference to the national guidelines. The *Queensland Water Quality Guidelines* (QWQG) (DERM 2009) have, therefore, been used where applicable. The relevant QWQG for the project area are the Central Coast Queensland regional guideline values for slightly to moderately disturbed waters. This includes specific water quality guidelines for both upland and lowland streams, as well as for wetlands.

Site-specific draft water quality objectives (WQO) (guideline values) have been derived for the Project and are presented within the Byerwen Coal Water Management Plan: Assessment of Surface Water Environmental Values prepared by Kellogg Brown & Root Pty Ltd (KBR). The WQO have been derived from the ANZECC/ARMCANZ guidelines, QWQG and local baseline water quality data and will be used as the basis for future management of water quality for the Project.

5.4.2 Australian River Assessment System

The Australian River Assessment System (AUSRIVAS) protocols (DNRM 2001) were followed during the collection and assessment of macroinvertebrate samples from survey sites. AUSRIVAS models were accessed to aid in results interpretation and in establishing the health and integrity of macroinvertebrate communities relative to reference sites in the broader region.

5.4.3 Aquatic Conservation Assessments

Previous Aquatic Conservation Assessments (ACAs) for the riverine and non-riverine wetlands of the Great Barrier Reef catchment, Burdekin region (Inglis and Howell 2009a, 2009b), were referenced to identify Priority species known to occur in the broader Burdekin catchment, which therefore have the potential to occur within the project area.

Priority fauna species are those species which exhibit one or more of the following significant values:

- It is endemic to the Burdekin region (>75% of its distribution is in the Burdekin region)
- It has experienced, or is suspected of experiencing, a series population declines
- It has experienced a significant reduction in its distribution and has a naturally restricted distribution in the Burdekin region
- It is currently a small population and threatened by loss of habitat
- It is a significant disjunct population
- It is a migratory species (other than birds)
- A significant proportion of the breeding population (>1% for waterbirds, >75% other species) occurs in the waterbody.

Priority flora species are those species which exhibit one or more of the following significant values:

- It forms significant macrophyte beds (in shallow or deep water)
- It is an important/critical food source
- It is important/critical habitat
- It is implicated in spawning or reproduction for other flora and/or fauna species
- It is at its distributional limit or is a disjunct population
- It provides stream bank or bed stabilisation or has soil-binding properties
- It is a small population and subject to threatening processes.

5.4.4 Back on Track Actions for Biodiversity

The 'Back on Track' species prioritisation framework identifies species that are in decline on a whole-of-Queensland scale but that also have good potential for recovery.

The *Burdekin Natural Resource Management (NRM) Region 'Back on Track' Actions for Biodiversity* (DERM 2010) aims to address the decline of species in the Burdekin NRM region, and was used to identify species with the potential to occur within the project area, and considered to be of Medium Priority, High Priority, or Critical Priority for conservation.

6. ASSESSMENT METHODOLOGY

This section details the methodologies and principles used in the desktop and field studies to establish the aquatic ecological values of the project area.

6.1 TAXONOMIC NOMENCLATURE

Scientific and common names of flora and vertebrate fauna species used in this report are consistent with those used by DEHP in their WildNet database. Scientific and common names for fishes are consistent with those used by Pusey *et al.* (2004) and Allen *et al.* (2002). Scientific and common names for invertebrate fauna species are consistent with those used by DNRM (2001) and Chessman (2003).

6.2 DESKTOP ASSESSMENT

The desktop assessment was undertaken in March 2012 and included a review of the following Commonwealth and State databases:

- The DSEWPaC EPBC Act Protected Matters Search Tool was used to identify MNES within approximately 20 km of the project area. The search area was defined by the GDA 1994 coordinates:
  - −20.90156, 147.62248
  - −20.89912, 148.10683
  - −21.56741, 148.11183
  - −21.56994, 147.62529
- DERM Queensland Wetlands 2009 (DEHP Wetland*Info*) mapping to determine the classification, extent, and significance of palustrine, lacustrine and riverine systems within the project area. It should be noted that DEHP has undertaken site assessment to specifically define drainage features into the categories of watercourses (assessable under the Water Act) and drainage lines (not assessable under the Water Act). DEHP-defined watercourses and drainage lines are shown in **Figure 4.1**
- DERM WetlandInfo Wetland Summary Information (including species listings) for the Burdekin Basin
- The Burdekin Natural Resource Management Region 'Back on Track' Actions for Biodiversity
- Aquatic Conservation Assessments for the riverine and non-riverine wetlands of the Great Barrier Reef catchment: Burdekin region
- Published ecological information on EVNT and special 'least concern' aquatic flora and fauna species.

6.3 FIELD ASSESSMENT

6.3.1 Site Selection

A total of 10 sites were surveyed within the project area to characterise representative aquatic ecosystems that may be impacted by the mine. These consisted of three sites within the Suttor River and its tributaries, four sites within Kangaroo Creek and its tributaries, and three wetland sites (one palustrine wetland, one lacustrine wetland, and one gilgai wetland). Sites within the Suttor River and its tributaries, and Kangaroo Creek

and its tributaries, were located both upstream and downstream of the mine. Locations of survey sites are shown in **Figure 3.1**. Detailed information on sampling sites and the samples collected is presented in **Table 6.1**.

Table 6.1 Details of Sites and Samples Collected during the Field Survey

Site	Site Code	Date Surveyed	Stream Order (Strahler)	Latitude GDA 1994	Longitude GDA 1994	Macroinvertebrate Samples		Water Chemistry	Habitat Assessment
						Bed Habitat	Edge Habitat		
Suttor River	S1	01/05/2012	5	−21.2883	147.8187	✓	✓	✓	✓
Lacustrine Wetland	S2	02/05/2012	NA	−21.2829	147.8406	✓	✓	✓	✓
Palustrine Wetland	S3	03/05/2012	NA	−21.2700	147.8191	-	✓	✓	✓
Suttor River Tributary	S4	03/05/2012	2	−21.3215	147.8333	✓	✓	✓	✓
Gilgai	S5	04/05/2012	NA	−21.2781	147.8559	-	*	-	✓
Suttor River Tributary	S6	04/05/2012	1	−21.3061	147.8849	✓	✓	✓	✓
Kangaroo Creek Tributary	S7	05/05/2012	3	−21.1440	147.8575	✓	✓	✓	✓
Kangaroo Creek Tributary	S8	05/05/2012	4	−21.1569	147.8538	✓	✓	✓	✓
Kangaroo Creek Tributary	S9	05/05/2012	3	−21.1340	147.8400	✓	✓	✓	✓
Kangaroo Creek Tributary	S10	06/05/2012	2	−21.2123	147.8422	✓	✓	✓	✓

Note *: Limited to sampling of freshwater crab (*Austrothelphusa transversa*) and fairy shrimp (*Branchinella* sp.).

6.3.2 Aquatic Habitats

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

It is important to note that AUSRIVAS protocols suggest a minimum of two survey events in a year. These events should be on a 'seasonal' basis, with at least one undertaken between May and July ('late wet'), and one undertaken between October and December ('early wet'). A late wet season survey was completed in May 2012 and an early wet season survey (for which results are not yet available) was completed in December 2012, complying with AUSRIVAS protocols.

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

6.3.3 Water Chemistry

Water quality measurements and water sampling were undertaken at all sites, with the exception of the gilgai (site S5), prior to any disturbance of the surrounding environment. Downstream sites were sampled first to ensure that results were not compromised through disturbance of upstream sampling sites.

Physico-chemical water quality parameters (pH, electrical conductivity, total dissolved solids, turbidity, dissolved oxygen and temperature), were measured and recorded using a calibrated multi-parameter water quality meter.

Water sampling was undertaken in accordance with *AS/NZS 5667.6 - Guidance on sampling of rivers and streams*. Water samples were collected from all sites, except site S5, from approximately 100 mm below the surface and well away from the bank. Samples were collected using appropriate laboratory supplied bottles specific to the analytes being tested. Details of each sample were recorded on a Chain of Custody (CoC) note. Sample bottles were stored on ice in an insulated sample storage container and delivered to ALS Environmental (Brisbane), a NATA (National Association of Testing Authorities) accredited laboratory, for analyses.

Water samples were analysed for the following:

- Major cations – calcium, magnesium, sodium, and potassium
- Major anions – chloride, sulphate, and alkalinity (carbonate and bicarbonate)
- Nutrients – ammonia, nitrite, nitrate, total Kjeldahl nitrogen, total nitrogen, total phosphorus, and reactive phosphorus.

Samples collected for nitrite, major cations, and reactive phosphorus exceeded recommended holding times between sampling and analyses. However, overall data integrity was sufficient to characterise the abiotic environment for the purposes of this aquatic ecology impact assessment.

Water Quality Guidelines

Water quality was assessed against the following guidelines:

- Queensland Water Quality Guidelines (QWQG) 2009 (DERM 2009) – regional guideline values for physico-chemical parameters, Central Coast region
- Australian and New Zealand Guidelines for Fresh and Marine Water Quality (encompassing the Australian Water Quality Guidelines – AWQG) (ANZECC and ARMCANZ 2000):
  - Default trigger values for physical and chemical stressors for tropical Australia for slightly disturbed ecosystems
  - Default trigger values for toxicants at 95% species protection level – slightly to moderately disturbed freshwater systems.

6.3.4 Aquatic Flora Survey

Presence/absence surveys of aquatic plants (macrophytes) were undertaken at all 10 sites. For streams, this involved a systematic survey of aquatic plants for a 100 m reach, while for wetlands this involved transects. All aquatic plant specimens collected were identified using available literature and keys. Algae were not surveyed during this assessment.

6.3.5 Aquatic Fauna Survey

Macroinvertebrates

The assessment of in-stream aquatic macroinvertebrate communities was undertaken by an accredited AUSRIVAS ecologist and in accordance with AUSRIVAS protocols for Queensland streams (DNRM 2001). AUSRIVAS specifies a qualitative, rapid bioassessment method that aims to consistently sample a wide diversity of macroinvertebrates, at each site, within a defined timeframe.

Dip nets with a triangular opening of 250 mm x 250 mm x 250 mm and with a 250 µm mesh were used to sample macroinvertebrates. To address variations in habitat preference, and to obtain an accurate assessment of macroinvertebrates through the entire water column at each site, samples were taken over a 100 m reach from two distinct aquatic habitats:

- Benthos – benthic (bed) samples were obtained using the kick-sampling method, which consists of kicking and disturbing the bed and sweeping the disturbance with a dip-net to capture dislodged macroinvertebrates over an aggregate distance of 10 m
- Littoral (edge) fringe – sampling for this habitat involved sweeping a dip-net amongst the vegetation of the bank in an upstream direction over an aggregate distance of 10 m.

Following collection, each sample was transferred to a plastic sorting tray, where contents were sorted, and macroinvertebrates 'live-picked' by an AUSRIVAS accredited ecologist, in accordance with AUSRIVAS protocols. Edge and bed samples were sorted separately. All picked specimens were placed into sorting jars and preserved with 70% ethanol.

Macroinvertebrates specimens were identified by an AUSRIVAS accredited taxonomist. All specimens were identified to family level, except those for which family level

identification is not required under the AUSRIVAS protocol. These included lower Phyla such as Porifera, Nematoda and Nemerta, Oligochaetes (freshwater worms), Acarina (mites), and microcrustacea such as Ostrocoda, Copepoda, and Cladocera. Chironomids (midges) were identified to sub-family taxonomic level.

Data Analysis

Data was used to calculate a number of community descriptors including:

- Taxa richness, which is the measure of the total number of taxa present at each site
- EPT richness, which is a measure of richness based only on the taxonomic orders Ephemeroptera (mayflies), Plecoptera (stoneflies) and Trichoptera (caddis flies). EPT richness is used as an indicator of stream health as these three orders are recognised as being highly sensitive to disturbance, and often intolerant to pollution. A high EPT richness suggests that the waterway is less likely to have been affected by pollution, as pollution-sensitive species are present. Conversely, a low EPT richness suggests that the waterway has been affected by pollution due to the absent of the pollution-sensitive species
- Stream Invertebrate Grade Number Average (SIGNAL 2) score, which is a biotic index system that allocates a value to each macroinvertebrate family, based largely upon their sensitivity to pollution. SIGNAL 2 scores, which are based on the presence or absence of macroinvertebrate families, can be used to infer the environmental quality of a site, and provide an indication of long-term water quality. A value of 10 indicates high sensitivity, 1 represents high tolerance. SIGNAL 2 scores were calculated, following the protocols of Chessman (1995, 2003) and Chessman *et al.* (1997)
- AUSRIVAS, which is a prediction system used to assess the biological health of Australian rivers, developed in 1994 under the National River Health Program. AUSRIVAS compares site data with regionally relevant reference conditions using predictive models. Results are reported using a standard index, which is used as a measure of biological impairment. Macroinvertebrate data were entered into the AUSRIVAS modelling program, which then provides information on the OE50 family and AUSRIVAS Bands. The OE50 is a score that compares the expected condition of the macroinvertebrate community with the observed condition. The OE50 shows the ratio of the number of families expected at that site to the number of families actually collected from each site with a probability of occurrence >50%. The expected number of families is the sum of the probabilities (P>0.5) for each taxon occurring at the site as calculated by the model. The AUSRIVAS model uses the OE50 score to assign a band that describes the condition class of the site.

Fish

Both passive and active sampling techniques were employed to characterise the fish assemblages at survey sites. Passive sampling techniques included baited traps and un-baited fyke nets. Active sampling techniques included seine nets and an LR-24 backpack electrofisher. The methods employed at each site were dictated by the site characteristics.

Four baited traps and two fyke nets were deployed overnight at sites S1, S2, S3, and S4. Traps and nets were positioned to allow for a diversity of structural habitat to be sampled (e.g., open water, amongst or against vegetation and woody material). Each fyke net was deployed with a float in the last hoop to allow access to air for any air breathing species captured (e.g. turtles). All captured fish were measured and released as soon as possible and as close to the point of capture as practicable.

A seine net was used at sites S1, S4, S6, S8 and S10 as they were not suitable for electrofishing due to poor clarity or the electrical conductivity of water being outside of the suitable range. Sites S2 and S3 were not suitable for seine netting due to obstruction by snags and macrophytes. Sites S7 and S9 had insufficient fish habitat, and high water clarity allowed a visual survey of the watercourse, which failed to detect fish.

Site S2 was the only site suitable to use the LR-24 backpack electrofisher unit. At this site the unit was used for a total 'power on' time of approximately 1200 seconds. All stunned specimens were collected using a dip net and transferred to an aerated holding tank, where they were measured and counted. No exotic fish were captured and all specimens were returned to the water as soon as possible.

Other sites were either too turbid (sites S1 and S10), shallow and without sufficient fish habitat (sites S7 and S9), too conductive (sites S6, S7 and S8), or not conductive enough (sites S3 and S4).

Attachment A indicates the method(s) of survey for fish captured at each site.

7. DESCRIPTION OF ENVIRONMENTAL VALUES

7.1 LITERATURE REVIEW

7.1.1 Communities of Conservation Significance

An EPBC Act Protected Matters Report (**Attachment B**) did not identify any 'Threatened Ecological Communities' relevant to aquatic ecosystems.

7.1.2 Wetlands

An EPBC Act Protected Matters Report (**Attachment B**) did not identify any wetlands of international significance (Ramsar wetlands) within or downstream of the project area.

The closest wetlands of national significance occur downstream of the project area. Birralee-Pelican Creek Aggregation (QLD198) on the Bowen River is 70km downstream and the Scartwater Aggregation (QLD204) on the flood plain of the Suttor River 220 km downstream of the project area. Given the distance from the project area, these wetlands are considered extremely unlikely to be impacted by the Project.

HES wetlands in GBR catchments (**Section 5.3**) are shown on the DEHP map of referable wetlands (DEHP 2012). HES wetlands fall within wetland protection areas (WPAs), which, in rural areas, include a 500 m buffer surrounding the HES wetland. A palustrine wetland on the Suttor River floodplain, within the project area, is classified as a HES wetland (**Section 7.2.2**). This HES wetland occurs on the western boundary of the project area and will remain undeveloped for the life of the mine.

An existing rail line (not associated with this Project) already intersects the 500 m buffer to the east of this HES wetland, and a proposed rail line (not associated within this Project), will also intersect the 500 m buffer in the same area. These railways are <400m from the HES wetland and lie between this HES wetland and the closest Project workings (West Pit 2), which are estimated to be 400-500m from the wetland. The rail infrastructure is likely to have altered the hydrology of the wetland although no baseline data are available to allow an assessment of change over time.

As the Project would be approved under the *Mineral Resources Act 1989* (MR Act), it is exempt from referrals and approvals under the SP Act (s319 of the MR Act), such as those for HES wetlands. However, consideration of impacts on this wetland, as well as mitigation measures, is considered in **Section** 8.

No other HES wetlands are encountered by the Project.

Two wetlands of general ecological significance, in this case lacustrine wetlands, fall within the proposed area of disturbance (**Section 7.2.3**).

7.1.3 Flora

A flora species list generated from Wetland*Info* (DERM 2012a) identified 157 wetland indicator plants as having been recorded in the broader Burdekin Basin.

Threatened and Priority Aquatic Flora Species

Of the aquatic flora species known to occur in the Burdekin Basin, two are listed as threatened ('Endangered' or 'Vulnerable') under the NC Act and/or EPBC Act; salt pipewort (*Eriocaulon carsonii*), which is 'Endangered' under the EPBC Act and NC Act; and frogbit (*Hydrocharis dubia*), which is 'Vulnerable' under the EPBC Act. Both of these

listed threatened species are also identified as Priority 'Back on Track' species for the Burdekin NRM region (DERM 2010). In addition, 13 aquatic flora species are listed as Priority species under the ACAs for riverine and non-riverine wetlands of the Great Barrier Reef Catchment (Inglis and Howell 2009a, 2009b).

Threatened and Priority aquatic flora species identified from the literature review are presented in **Table 7.1**, along with a preferred habitat description and commentary on the likelihood of occurrence within the project area.

Table 7.1 Threatened and Priority Aquatic Flora Species Known to Occur in the Burdekin Basin

Scientific Name	Common Name	Status				Importance and Habitat Description	Likelihood of Occurring within Project area	Data Source				
		EPBC Act[1]	NC Act[2]	Back on Track[3]	ACA[4]			Inglis and Howell, 2009a	Inglis and Howell, 2009b	DSEWPAC 2012	DERM, 2012	DERM, 2012a
Threatened Species												
Eriocaulon carsonii	Salt pipewort	E	E	C/H	R&T	Restricted to saturated soil adjacent to flowing mound springs (Sainty and Jacobs 2003).	**Unlikely**. Current known distribution is not in proximity to the Project area. Mound springs not known to occur within the Project area. Preferred habitat unlikely to be present within the Project area.		✓		✓	✓

Scientific Name	Common Name	Status				Importance and Habitat Description	Likelihood of Occurring within Project area	Data Source				
		EPBC Act[1]	NC Act[2]	Back on Track[3]	ACA[4]			Inglis and Howell, 2009a	Inglis and Howell, 2009b	DSEWPAC 2012	DERM, 2012	DERM, 2012a
Hydrocharis dubia	Frogbit	V	LC[4]	H/M	R&T	Prefers to grow in small shallow freshwater bodies or swamps (DSEWPaC 2008).	**Unlikely**. Recorded only from south-east Queensland, and from Ayr and Charters Towers in the northern Burdekin basin (Stephens and Dowling, 2002). Although suitable habitat occurs within the broader project area, this species has not been recorded from the Bowen or Belyando catchments of the Burdekin basin (i.e., the catchments that encompass the Project site).		✓		✓	✓

[4] As shown for frogbit, a species' conservation status can be different under Commonwealth and State legislation. The status assigned to a species under particular legislation is applicable only to interpretation of that legislation and should not be construed otherwise (e.g. identification of frogbit as a Least Concern species under the NC Act does not diminish its status under the EPBC Act).

Scientific Name	Common Name	Status				Importance and Habitat Description	Likelihood of Occurring within Project area	Data Source				
		EPBC Act[1]	NC Act[2]	Back on Track[3]	ACA[4]			Inglis and Howell, 2009a	Inglis and Howell, 2009b	DSEWPAC 2012	DERM, 2012	DERM, 2012a
Priority Species												
arsilea drummondii	Common nardoo	-	LC	-	P	Occurs within or surrounding shallow freshwater depressions, billabongs, swamps, and temporary waterholes (Stephens and Dowling 2002). Forms a key threatened macrophyte community on the Burdekin floodplain (Inglis and Howell 2009b). It provides bank stability, helps retain surface moisture in wetlands during dry periods, and provides habitat for amphibians and invertebrates.	**Known**. Recorded during field survey in May 2012 (**Section 7.4**).		✓			✓
Ceratopteris thalictroides	Water fern	-	LC	-	P	Prefers to grow in muddy environments, submerged or emergent, or free-floating just below the water surface (Stephens and Dowling 2002; Leiper *et al.* 2008). An indicator of relatively good water quality (Inglis and Howell, 2009b).	**Likely**. Suitable habitat occurs within the Project site.	✓	✓			✓

Scientific Name	Common Name	Status				Importance and Habitat Description	Likelihood of Occurring within Project area	Data Source				
		EPBC Act[1]	NC Act[2]	Back on Track[3]	ACA[4]			Inglis and Howell, 2009a	Inglis and Howell, 2009b	DSEWPAC 2012	DERM, 2012	DERM, 2012a
Aponogeton queenslandicus		-	LC	-	R&T*	An emergent plant that prefers 30–60 cm deep, temporary, freshwater, clay bottom pools, exposed to full sun. It is not usually found in permanent waters (Stephens and Dowling 2002).	**Likely**. Suitable habitat occurs within the Project site, including gilgai (**Section 7.2.4**).		✓			✓
Eleocharis dulcis	Water chestnut	-	LC	-	P	Prefers shallow water lagoons and floodplains on heavy self-mulching soils (Sainty and Jacobs 2003). Forms large areas of monotypic sedgeland that is a key threatened wetland community in Burdekin Dry Tropics (Inglis and Howell 2009b).	**Known**. Recorded during field survey in May 2012.		✓			✓
Eleocharis sphacelata	Tall spikerush	-	LC	-	P	Found in coastal and near-coastal regions of Queensland, in areas that are shallowly or deeply inundated. It is often found in areas with muddy substrate (Stephens and Dowling 2002). Subject to threatening processes (Inglis and Howell 2009b).	**Likely**. Suitable habitat occurs within the Project site.		✓			✓

Scientific Name	Common Name	Status				Importance and Habitat Description	Likelihood of Occurring within Project area	Data Source				
		EPBC Act[1]	NC Act[2]	Back on Track[3]	ACA[4]			Inglis and Howell, 2009a	Inglis and Howell, 2009b	DSEWPAC 2012	DERM, 2012	DERM, 2012a
Hydrilla verticillata	Hydrilla	-	LC	-	P	Grows as a submerged aquatic plant that is attached to the bottom by stems up to 2 m in length. It often forms dense mats just below the water surface. Common in freshwater lakes, pools, and slow-moving streams throughout coastal areas of Queensland (Stephens and Dowling 2002).	**Likely**. Suitable habitat occurs within the Project site.	✓	✓			✓
Nymphaea gigantea	Giant waterlily	-	LC	-	P	Found in still water to 1.5 m deep, mainly in coastal lagoons, though it does occur in some inland lagoons. It is more commonly found in northern tropical areas than elsewhere in Queensland (Stephens and Dowling 2002).	**Possible**. Marginal habitat occurs within the Project site, including farm dams.		✓			✓

Scientific Name	Common Name	Status				Importance and Habitat Description	Likelihood of Occurring within Project area	Data Source				
		EPBC Act[1]	NC Act[2]	Back on Track[3]	ACA[4]			Inglis and Howell, 2009a	Inglis and Howell, 2009b	DSEWPAC 2012	DERM, 2012	DERM, 2012a
Ottelia alismoides	Ottelia	-	LC	-	P	Occurs in slow moving streams, and stagnant pools up to 2 m deep, in coastal Queensland where it is widespread but not usually common (Stephens and Dowling 2002). Presence of the species indicates macrophyte communities are in good condition, as this species depends on ideal growing environment such as sunny, shallow margins, and good water quality (Inglis and Howell 2009b).	**Possible**. Marginal habitat occurs within the Project site, including farm dams.		✓			✓
Ottelia ovalifolia	Swamp lily	-	LC	-	P	Found in still waters of ponds and dams, and in muddy substrates of slow-moving streams (Stephens and Dowling 2002). Important food source for fish, vertebrates and waterbirds, especially during winter (Inglis and Howell 2009b).	**Likely**. Suitable habitat occurs within the Project site.		✓			✓
Vallisneria nana		-	LC	-	P	Prefers fast-flowing waters of streams, lakes, ponds, and irrigation channels (Stephens and Dowling 2002).	**Possible**. Marginal habitat occurs within the Project site.	✓	✓			✓

Scientific Name	Common Name	Status				Importance and Habitat Description	Likelihood of Occurring within Project area	Data Source				
		EPBC Act[1]	NC Act[2]	Back on Track[3]	ACA[4]			Inglis and Howell, 2009a	Inglis and Howell, 2009b	DSEWPAC 2012	DERM, 2012	DERM, 2012a
Hymenachne acutigluma		-	LC	-	P	Occurs in north Queensland in shallow water at the margins of swamps and slow-flowing rivers (Stephens and Dowling 2002).	**Likely**. Suitable habitat occurs within the Project site.	✓	✓			✓
Leersia hexandra	Swamp rice grass	-	LC	-	P	Occurs in, and beside shallow swamps and creeks in the eastern part of Queensland (Stephens and Dowling, 2002).	**Known**. Recorded during field survey in May 2012.	✓	✓			✓
Pseudoraphis spinescens	Spiny mudgrass	-	LC	-	P	Found in shallow water or mud beside creeks and drainage lines throughout Queensland (Stephens and Dowling 2002). Threatened through exclusion by para grass (*Brachiaria mutica*) and other exotics in floodplain habitats. It is an indicator of habitat integrity and provides good waterfowl habitat (Inglis and Howell 2009b).	**Likely**. Suitable habitat occurs within the Project site.		✓			✓

Notes:
E = endangered, V = vulnerable, LC = least concern, C = critical priority, H = high priority, M = medium priority, P = priority, R&T = rare and threatened.
1 EPBC Act = Status under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*.
2 NC Act = Status under the Queensland *Nature Conservation Act 1992*.
3 Back on Track = Status under the DERM (2010) Burdekin Natural Resource Management Region - Back on Track Actions for Biodiversity.
4 ACA = Status under the Aquatic Conservation Assessments using AquaBAMM for riverine and non-riverine wetlands of the Great Barrier Reef catchments (Inglis and Howell 2009a, 2009b).

* Aponogeton queenslandicus is listed as Rare in AquaBAMM, for the riverine and non-riverine wetlands of the Great Barrier Reef catchment: Burdekin region. However, as of 21 May 2010, this species is a Least Concern species under the NC Act.

References:

- Inglis and Howell (2009a) Aquatic Conservation Assessments, using AquaBAMM, for the riverine wetlands of the Great Barrier Reef catchment: Burdekin region.
- Inglis and Howell (2009b) Aquatic Conservation Assessments, using AquaBAMM, for the non-riverine wetlands of the Great Barrier Reef catchment: Burdekin region.
- Commonwealth Department of Sustainability, Environment, Water, Population and Communities (DSEWPAC 2012), EPBC Act Protected Matters Report – created 23/02/2012.
- Queensland Department of Environment and Resource Management (DERM 2010). Burdekin Natural Resource Management Region – Back on Track Actions for Biodiversity.
- Queensland Department of Environment and Resource Management (DERM 2012a). WetlandInfo – Burdekin Basin – Wetland Summary Information.

7.1.4 Fauna

A fauna species list generated from Wetland*Info* (DERM 2012a) identified 49 native fishes, two alien fishes, three semi-aquatic mammals, five turtles, and the saltwater crocodile, *Crocodylus porosus*, as having been recorded in the broader Burdekin Basin. These species are listed in **Table 7.2**.

Table 7.2 Aquatic Vertebrate Fauna Species Known to Occur in the Burdekin Basin

Scientific Name	Common Name	Conservation Status			
		EPBC Act[1]	NC Act[2]	Back on Track[3]	ACA[4]
Native Fishes					
Neoceratodus forsteri	Australian lungfish	V	LC	-	-
Glossogobius giuris	Tank goby	-	LC	-	-
Redigobius bikolanus	Speckled goby	-	LC	-	-
Eleotris melanosoma	Black spine-cheek gudgeon	-	LC	-	-
Giuris margaritacea	Snakehead gudgeon	-	LC	-	P
Hypseleotris compressa	Empire gudgeon	-	LC	-	-
Hypseleotris galii	Firetail gudgeon	-	LC	-	-
Hypseleotris klunzingeri	Western carp gudgeon	-	LC	-	-
Hypseleotris species 1	Midgley's carp gudgeon	-	LC	-	-
Mogurnda adspersa	Southern purple-spotted gudgeon	-	LC	-	P
Mogurnda mogurnda	Northern purple-spotted gudgeon	-	LC	-	-
Oxyeleotris lineolata	Sleepy cod	-	LC	-	-
Philypnodon grandiceps	Flathead gudgeon	-	LC	-	P
Mugil cephalus	Sea mullet	-	LC	-	-
Toxotes chatareus	Seven-spot archerfish	-	LC	-	-
Lutjanus argentimaculatus	Mangrove jack	-	LC	-	-
Glossamia aprion	Mouth almighty	-	LC	-	-
Kuhlia rupestris	Jungle perch	-	LC	-	P
Amniataba percoides	Barred grunter	-	LC	-	-
Hephaestus fuliginosus	Sooty grunter	-	LC	-	-
Leiopotherapon unicolor	Spangled perch	-	LC	-	-
Scortum hillii	Leathery grunter	-	LC	-	-
Scortum parviceps	Smallhead grunter	-	LC	-	P
Macquaria ambigua	Golden perch	-	LC	-	-
Ambassis agassizii	Agassiz's glassfish	-	LC	-	-
Ambassis agrammus	Sailfin glassfish	-	LC	-	P

Scientific Name	Common Name	Conservation Status			
		EPBC Act[1]	NC Act[2]	Back on Track[3]	ACA[4]
Ambassis miops	Flagtail glassfish	-	LC	-	-
Ambassis species	Northwest glassfish	-	LC	-	-
Lates calcarifer	Barramundi	-	LC	-	-
Notesthes robusta	Bullrout	-	LC	-	-
Arrhamphus sclerolepis	Snubnose garfish	-	LC	-	-
Strongylura krefftii	Freshwater longtom	-	LC	-	P
Craterocephalus marjoriae	Silverstreak hardyhead	-	LC	-	-
Craterocephalus stercusmuscarum	Flyspecked hardyhead	-	LC	-	-
Pseudomugil signifer	Pacific blue eye	-	LC	-	-
Melanotaenia splendida splendida	Eastern rainbowfish	-	LC	-	-
Melanotaenia splendida tatei	Desert rainbowfish	-	LC	-	-
Neosilurus ater	Black catfish	-	LC	-	-
Neosilurus hyrtlii	Hyrtl's tandan	-	LC	-	-
Neosilurus mollespiculum	Softspine catfish	-	LC	-	P
Neosilurus pseudospinosus	Falsespine catfish	-	LC	-	-
Porochilus rendahli	Rendahl's catfish	-	LC	-	-
Tandanus tandanus	Freshwater catfish	-	LC	-	-
Neoarius graeffei	Blue catfish	-	LC	-	-
Nematalosa erebi	Bony bream	-	LC	-	-
Anguilla obscura	Pacific shortfin eel	-	LC	-	P
Anguilla reinhardtii	Longfin eel	-	LC	-	P
Megalops cyprinoides	Oxeye herring	-	LC	-	-
Scleropages leichardti	Southern saratoga	-	LC	-	-
Alien Fishes					
Trichogaster trichopterus	Blue gourami	-	-	-	-
Gambusia holbrooki	Mosquito fish	-	-	-	-
Turtles					
Chelodina canni	Cann's longneck turtle	-	LC	-	-
Chelodina longicollis	Eastern snake-necked turtle	-	LC	-	-
Elseya irwini	Irwin's turtle	-	LC	H/H	P
Emydura macquarii krefftii	Krefft's river turtle	-	LC	-	-
Wollumbinia latisternum	Saw-shelled turtle	-	LC	-	-

Scientific Name	Common Name	Conservation Status			
		EPBC Act[1]	NC Act[2]	Back on Track[3]	ACA[4]
Crocodiles					
Crocodylus porosus	Estuarine crocodile	Ma/Mi	V	-	R&T
Mammals					
Hydromys chrysogaster	Water rat	-	LC	-	-
Rattus lutreolus	Swamp rat	-	LC	-	-
Ornithorhynchus anatinus	Platypus	-	SC	-	-

Notes:
E = endangered, V = vulnerable, LC = least concern, C = critical priority, H = high priority, M = medium priority, P = priority, R&T = rare and threatened.
1. EPBC Act = Status under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*.
2. NC Act = Status under the Queensland *Nature Conservation Act 1992*.
3. Back on Track = Status under the DERM (2010) Burdekin Natural Resource Management Region - Back on Track Actions for Biodiversity.
4. ACA = Status under the Aquatic Conservation Assessments using AquaBAMM for riverine and non-riverine wetlands of the Great Barrier Reef catchments (Inglis and Howell 2009a, 2009b).

Threatened, Priority and Special Least Concern Aquatic Fauna Species

Of the aquatic fauna species known to occur in the Burdekin Basin, two are listed as threatened ('Endangered' or 'Vulnerable') under the NC Act and/or the EPBC Act; The Australian lungfish (*Neoceratodus forsteri*), which is listed as 'Vulnerable' under the EPBC Act, and; the estuarine crocodile, which is listed as 'Vulnerable' under the NC Act. None are listed as Near Threatened. The platypus (*Ornithorhynchus anatinus*) is listed as 'Special Least Concern' under the NC Act. In addition, 11 aquatic fauna species are listed as 'Priority' species under the ACA's for riverine and/or non-riverine wetlands of the Great Barrier Reef Catchments (Inglis and Howell 2009a, 2009b). One of these species, Irwin's turtle (*Elseya irwini*), is also listed as a 'High Priority' Back on Track species for the Burdekin NRM region (DERM 2010).

'Threatened', 'Special Least Concern' and 'Priority' aquatic fauna species identified from the literature review are presented in **Table 7.3**, along with a preferred habitat description and commentary on the likelihood of individual species occurring within the Project site.

Table 7.3 Threatened and Priority Aquatic Fauna Species Known to Occur in the Burdekin Basin

Scientific Name	Common Name	Status				Importance and Habitat Description	Likelihood of Occurring within Project area	Data Source				
		EPBC Act[1]	NC Act[2]	Back on Track[3]	ACA[4]			Inglis and Howell 2009a	Inglis and Howell 2009b	DSEWPAC 2012	DERM 2010	DERM 2012a
Mammals												
Ornithorhynchus anatinus	Platypus	-	SC	-	-	Inhabits freshwater streams, ranging from alpine creeks to tropical lowland rivers; also lakes, shallow reservoirs, and farm dams; preferring areas with steep vegetated banks in which to burrow (Menkhorst and Knight 2004). Cultural significance.	**Unlikely**. No historical or contemporary reports of platypus presence in the Burdekin River basin, apart from populations at the extreme latitudinal margins. Both of these locations are in regions of cool upland rainforest, while the low-lying area between them is much warmer, more arid and, according to bioclimatic modelling, not suitable for the platypus (Kolomyjec 2010).					✓

Scientific Name	Common Name	Status				Importance and Habitat Description	Likelihood of Occurring within Project area	Data Source				
		EPBC Act[1]	NC Act[2]	Back on Track[3]	ACA[4]			Inglis and Howell 2009a	Inglis and Howell 2009b	DSEWPAC 2012	DERM 2010	DERM 2012a
Reptiles												
Crocodylus porosus	Estuarine crocodile	Ma/ Mi	V	-	R&T	Usually inhabits the lower reaches of coastal rivers, swamps, estuaries, and open sea (Wilson 2005). In Queensland the species is usually restricted to coastal waterways, and floodplain wetlands (DSEWPaC 2012); however, may also be found hundreds of kilometres upstream (Read *et al.* 2004).	**Unlikely**. Suitable habitat within the Project area is extremely limited. Waterways of the Project area are of relatively low stream order, and positioned high in the catchment. Substantial barriers/weirs occur on the Suttor River downstream of the Project area and are likely to form physical barriers to the passage of estuarine crocodiles.	✓	✓	✓		✓

Scientific Name	Common Name	Status				Importance and Habitat Description	Likelihood of Occurring within Project area	Data Source				
		EPBC Act[1]	NC Act[2]	Back on Track[3]	ACA[4]			Inglis and Howell 2009a	Inglis and Howell 2009b	DSEWPAC 2012	DERM 2010	DERM 2012a
Elseya irwini	Irwin's turtle	-	LC	H	P	Endemic to the Burdekin basin (Inglis and Howell 2009a). Occurs in clear, well-oxygenated water where flow is continuous (i.e., not seasonal), and substrates which comprise exposed sand and rock (TSSC 2009).	**Unlikely**. Stream flows in project area are seasonal. The species is only known from an area upstream from the township of Ayr, Queensland; specifically, the Broken River, and tributaries downstream from Eungella Dam, as far as, and including, the Bowen River, and part of the Burdekin River. Extent of occurrence is estimated at 25 km^2 (TSSC 2009). The Project site is outside of the known geographic range of this species.	✓			✓	✓

Scientific Name	Common Name	Status				Importance and Habitat Description	Likelihood of Occurring within Project area	Data Source				
		EPBC Act[1]	NC Act[2]	Back on Track[3]	ACA[4]			Inglis and Howell 2009a	Inglis and Howell 2009b	DSEWPAC 2012	DERM 2010	DERM 2012a
Fishes												
Neoceratodus forsteri	Australian lungfish	V	LC	-	-	Restricted to SEQ, where it occurs naturally in the Burnett and Mary rivers, and possibly the Brisbane River (Pusey *et al.* 2004). Prefers slow-flowing rivers and still water (including reservoirs) with aquatic vegetation on the banks (Allen *et al.* 2002). Most common in deep pools with mud, sand, or gravel substrate (Allen *et al.* 2002).	**Unlikely**. Last recorded sighting in the Burdekin basin was in 1870. Current known distribution not in proximity to the Project site.					✓

Scientific Name	Common Name	Status				Importance and Habitat Description	Likelihood of Occurring within Project area	Data Source				
		EPBC Act[1]	NC Act[2]	Back on Track[3]	ACA[4]			Inglis and Howell 2009a	Inglis and Howell 2009b	DSEWPAC 2012	DERM 2010	DERM 2012a
Giuris margaritacea	Snake-head gudgeon	-	LC	-	P	Inhabits rivers, swamps, coastal streams, and floodplains. Found over mud bottoms, often amongst dense aquatic vegetation, or under the cover of undercut banks (Allen *et al.* 2002). Most of their lives are spent in freshwater but migrate to the estuarine/ brackish areas to breed (i.e., catadromous). Their presence indicates coastal hydrological connectivity. Intolerant of low dissolved oxygen levels.	**Unlikely**. Poorly suited to low dissolved oxygen levels, which are expected (and encountered) across the Project site during drier months. Physical barriers inhibit connectivity with the sea and the consequent persistence of this species in waterways upstream of Burdekin Dam.	✓				✓

Scientific Name	Common Name	Status				Importance and Habitat Description	Likelihood of Occurring within Project area	Data Source				
		EPBC Act[1]	NC Act[2]	Back on Track[3]	ACA[4]			Inglis and Howell 2009a	Inglis and Howell 2009b	DSEWPAC 2012	DERM 2010	DERM 2012a
Mogurnda adspersa	Southern purple-spotted gudgeon	-	LC	-	P	A widespread species (Pusey *et al.*, 2004) occurring in rivers, creeks, and billabongs, usually quiet or slow-flowing sections, over rocks, or among vegetation (Allen *et al.*, 2002). Declining populations and local extinctions are occurring and translocations of the sleepy cod (*Oxyeleotris lineolata*) and golden perch (*Macquaria ambigua*) to upper catchments are placing direct pressure on this species (Inglis and Howell 2009a).	**Known**. Recorded during field surveys May 2012.	✓	✓			✓

Scientific Name	Common Name	Status				Importance and Habitat Description	Likelihood of Occurring within Project area	Data Source				
		EPBC Act[1]	NC Act[2]	Back on Track[3]	ACA[4]			Inglis and Howell 2009a	Inglis and Howell 2009b	DSEWPAC 2012	DERM 2010	DERM 2012a
Philypnodon grandiceps	Flathead gudgeon	-	LC	-	P	Prefers lakes, reservoirs and brackish estuaries, with mud bottoms, often among aquatic vegetation. Less common in gently flowing streams (Allen *et al.* 2002). Restricted in distribution (Inglis and Howell 2009a).	**Possible**. In central Queensland, this species has been recorded as far north as the Burdekin River, near Townsville. However, it is considered uncommon, as only a few individuals having been collected from two separate locations (Pusey *et al.* 2004).	✓	✓			✓
Kuhlia rupestris	Jungle perch	-	LC	-	P	Prefers fast-flowing streams and rivers, usually in rainforest. Also inhabits rocky pools at the base of waterfalls (Allen *et al.* 2002). Population numbers and extent of distribution has been in decline over recent decades, due to its sensitivity to changes in water quality, reliance on intact riparian vegetation, and dependence on connectivity to other habitats (Inglis and Howell 2009a).	**Unlikely**. Known to have occurred in the Burdekin Catchment; however, has not been recorded there in recent decades. Current known distribution is not in proximity to the Project site, most certainly due to the existence of downstream barriers such as Clare and Collinsville Weirs (Pusey *et al.* 2004).. Habitat unlikely to occur in Project site.	✓				✓

Scientific Name	Common Name	Status				Importance and Habitat Description	Likelihood of Occurring within Project area	Data Source				
		EPBC Act[1]	NC Act[2]	Back on Track[3]	ACA[4]			Inglis and Howell 2009a	Inglis and Howell 2009b	DSEWPAC 2012	DERM 2010	DERM 2012a
Scortum parviceps	Small-headed grunter	-	LC	-	P	Prefers to swim close to the bottom of swift-flowing streams, near rapids, in clear fresh water. Increasing turbidity thought to be a threat to its habitat range (Inglis and Howell 2009a).	**Unlikely**. Recorded only in the upper Burdekin river system (Allen *et al.* 2002). Waterways of the Project site are unlikely to provide adequate flow and clarity to sustain suitable habitat.	✓				✓
Ambassis agrammus	Sailfin glassfish	-	LC	-	P	Prefers rivers and creeks flowing through rainforest. Sometimes occurs in stagnant pools, or slowly flowing rivulets. Also found on the margins of swamps and lakes (Allen *et al.* 2002).	**Unlikely**. Recorded from wetlands of the Burdekin River delta, where it appears to be the southern limit for this species (Pusey *et al.* 2004). Widely distributed in the lower reach floodplains, which are highly impacted by agriculture (Inglis and Howell 2009a). Current known distribution not in proximity to the Project site.	✓				✓

Scientific Name	Common Name	Status				Importance and Habitat Description	Likelihood of Occurring within Project area	Data Source				
		EPBC Act[1]	NC Act[2]	Back on Track[3]	ACA[4]			Inglis and Howell 2009a	Inglis and Howell 2009b	DSEWPAC 2012	DERM 2010	DERM 2012a
Strongylura krefftii	Fresh-water longtom	-	LC	-	P	Prefers still or flowing waters of larger rivers, from tidal reaches to far inland. Also occurs in some impoundments. Often shelters amongst overhanging vegetation or submerged roots. Adults sometimes found in coastal marine waters (Allen *et al.* 2002). This species is a floodplain breeder, alienation of floodplain habitat physically, or exposure to low dissolved oxygen is a concern (Inglis and Howell 2009a).	**Possible**. Occurs in Burdekin River, penetrating into the Bowen River (Pusey *et al.* 2004). Suttor River provides marginal habitat.	✓	✓			✓

Scientific Name	Common Name	Status				Importance and Habitat Description	Likelihood of Occurring within Project area	Data Source				
		EPBC Act[1]	NC Act[2]	Back on Track[3]	ACA[4]			Inglis and Howell 2009a	Inglis and Howell 2009b	DSEWPAC 2012	DERM 2010	DERM 2012a
Neosilurus mollespiculum	Softspine catfish	-	LC	-	P	Prefers rocky pools in main river channels and larger creeks (Allen *et al.* 2002). Population potentially impacted since 1970s by translocated freshwater catfish (*Tandanus tandanus*) (Inglis and Howell 2009a).	**Possible**. Endemic to the Burdekin region with a patchy distribution in the Burdekin River catchment. In the upper Burdekin River, it occurs in tributary rivers as well as the main channel (Pusey *et al.* 2004). Has been recorded in the north of the project area (Kangaroo Creek and its tributaries). Not previously recorded in the Belyando/Suttor system (southern project area).	✓				✓

Scientific Name	Common Name	Status				Importance and Habitat Description	Likelihood of Occurring within Project area	Data Source				
		EPBC Act[1]	NC Act[2]	Back on Track[3]	ACA[4]			Inglis and Howell 2009a	Inglis and Howell 2009b	DSEWPAC 2012	DERM 2010	DERM 2012a
Anguilla obscura	Pacific shortfin eel	-	LC	-	P	Prefers freshwater streams, lakes, and swamps, favouring coastal lagoons and the lower reaches of rivers. Spawning adults occur in marine waters (Allen *et al.* 2002). Presence indicates good habitat connectivity. Evidence suggests the population above Burdekin Dam is in decline (Inglis and Howell 2009a). Numbers declining state-wide due to over fishing and fish barriers.	**Unlikely**. The Project site provides only marginal habitat. Poor habitat connectivity likely to limit the success of *A. obscura* in the broader project area.	✓	✓			✓

Scientific Name	Common Name	Status				Importance and Habitat Description	Likelihood of Occurring within Project area	Data Source				
		EPBC Act[1]	NC Act[2]	Back on Track[3]	ACA[4]			Inglis and Howell 2009a	Inglis and Howell 2009b	DSEWPAC 2012	DERM 2010	DERM 2012a
Anguilla reinhardtii	Longfin eel	-	LC	-	P	Occurs in freshwater streams, lakes, and swamps, with a preference for flowing water. Known to inhabit deep waters of reservoirs well away from the shore. Adults undertake annual spawning migrations to oceanic waters (Allen *et al.* 2002). Populations declining state-wide, due to over fishing and fish barriers (Inglis and Howell 2009a).	**Unlikely**. In the Burdekin, generally restricted to the lower reaches downstream of Burdekin Falls Dam. Some large individuals occur upstream of the dam, although numbers are declining as such individuals emigrate at times of high flow and recruitment is denied by the presence of the dam (Pusey *et al.* 2004). The Project site provides only marginal habitat. Poor habitat connectivity likely to limit the success of *A. reinhardtii* in the broader project area.	✓	✓			✓

Notes:
E = endangered, V = vulnerable, LC = least concern, C = critical priority, H = high priority, M = medium priority, P = priority, R&T = rare and threatened.
1 EPBC Act = Status under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*.
2 NC Act = Status under the Queensland *Nature Conservation Act 1992*.
3 Back on Track = Status under the DERM (2010) Burdekin Natural Resource Management Region - Back on Track Actions for Biodiversity.
4 ACA = Status under the Aquatic Conservation Assessments using AquaBAMM for riverine and non-riverine wetlands of the Great Barrier Reef catchments (Inglis and Howell 2009a, 2009b).
* Aponogeton queenslandicus is listed as Rare in AquaBAMM, for the riverine and non-riverine wetlands of the Great Barrier Reef catchment: Burdekin region. However, as of 21 May 2010, this species is a Least Concern species under the NC Act.

References:
- Inglis and Howell (2009a) Aquatic Conservation Assessments, using AquaBAMM, for the riverine wetlands of the Great Barrier Reef catchment: Burdekin region.
- Inglis and Howell (2009b) Aquatic Conservation Assessments, using AquaBAMM, for the non-riverine wetlands of the Great Barrier Reef catchment: Burdekin region.
- Commonwealth Department of Sustainability, Environment, Water, Population and Communities (DSEWPAC 2012), EPBC Act Protected Matters Report – created 23/02/2012.
- Queensland Department of Environment and Resource Management (DERM 2010). Burdekin Natural Resource Management Region – Back on Track Actions for Biodiversity.
- Queensland Department of Environment and Resource Management (DERM 2012a). WetlandInfo – Burdekin Basin – Wetland Summary Information.

7.2 AQUATIC HABITAT AND VALUES

7.2.1 Riverine Systems, Watercourses and Drainage Lines

The project area encompasses the Upper Suttor River sub-catchment in the south and the Rosella Creek sub-catchment in the north (**Figure 3.1**).

In the Upper Suttor River sub-catchment, the broadly defined Queensland Wetland Map 2009 (DERM 2012b) shows 15 riverine systems or drainage lines, including:

- One 5th order stream (the Suttor River)
- One 3rd order stream
- Three 2nd order streams
- Ten 1st order streams.

In the Rosella Creek sub-catchment, the project area includes 95 riverine systems or drainage lines mapped by DERM (2012b), including:

- One 4th order stream
- Five 3rd order streams
- Sixteen 2nd order streams
- Seventy-three 1st order streams.

DEHP has made an assessment of drainage features within the project area which meet the definition of a watercourse for the purpose of assessment under the Water Act (DERM 19 July 2012). These watercourses are shown in **Figure 4.1**. The remaining drainage features are simply defined as drainage lines.

The drainage lines within the project area are expected to experience flow only after sustained or intense rainfall in the catchment. Stream flows are highly variable, with most channels expected to dry out during the months of August and September, when rainfall and runoff is historically low. During these times, aquatic fauna are concentrated in senescing pools. As a consequence, physical attributes, water quality, and the composition of aquatic floral and faunal communities, are expected to be highly variable over time.

The Suttor River is the largest waterway that intersects the project area and has a catchment area of approximately 704 km^2. Data from the DERM gauging station on the Suttor River at Eaglefield (Station No. 120304), approximately 25 km downstream of the project area, indicates that average daily stream flows exceed a median of zero (i.e., flow is encountered more than half the time) only in the wetter months of January, February and March. During other months, this reach of the Suttor River is expected to have low to no flow.

At the time of the site surveys in May 2012, recessional baseflows were encountered on the Suttor River (site S1), and at three stream sampling sites in the Kangaroo Creek catchment (sites S7, S8 and S9). Flows had declined to isolated standing pools at sites S4 and S6 in the Suttor River catchment, and at site S10 in the Kangaroo Creek catchment.

River height data for the Suttor River gauging station at Eaglefield shows that a flood event occurred in March 2012, following intense rainfall and runoff in the catchment. Flood levels in the Suttor River at Eaglefield peaked on 19 March 2012, and again on

21 March, at approximately 8.5 m above the base flow level (**Figure 7.1**). It is inferred that intense rainfall is likely to have occurred across the broader project area during this period, including in the northern parts of the project area that fall within the Kangaroo Creek catchment.

According to the DNRM (2001), aquatic ecological sampling should be avoided for 4 to 6 weeks following a flood event, unless the impact of flood is being investigated. This is because flood conditions can flush waterways, disbursing sediments and benthic organisms either downstream or across a much broader stream cross-section. The late wet sampling event was undertaken 6 to 7 weeks following the flood event which is in accordance with Queensland AUSRIVAS protocol. A further 'early wet' season survey has been completed (December 2012) for which results are currently unavailable.

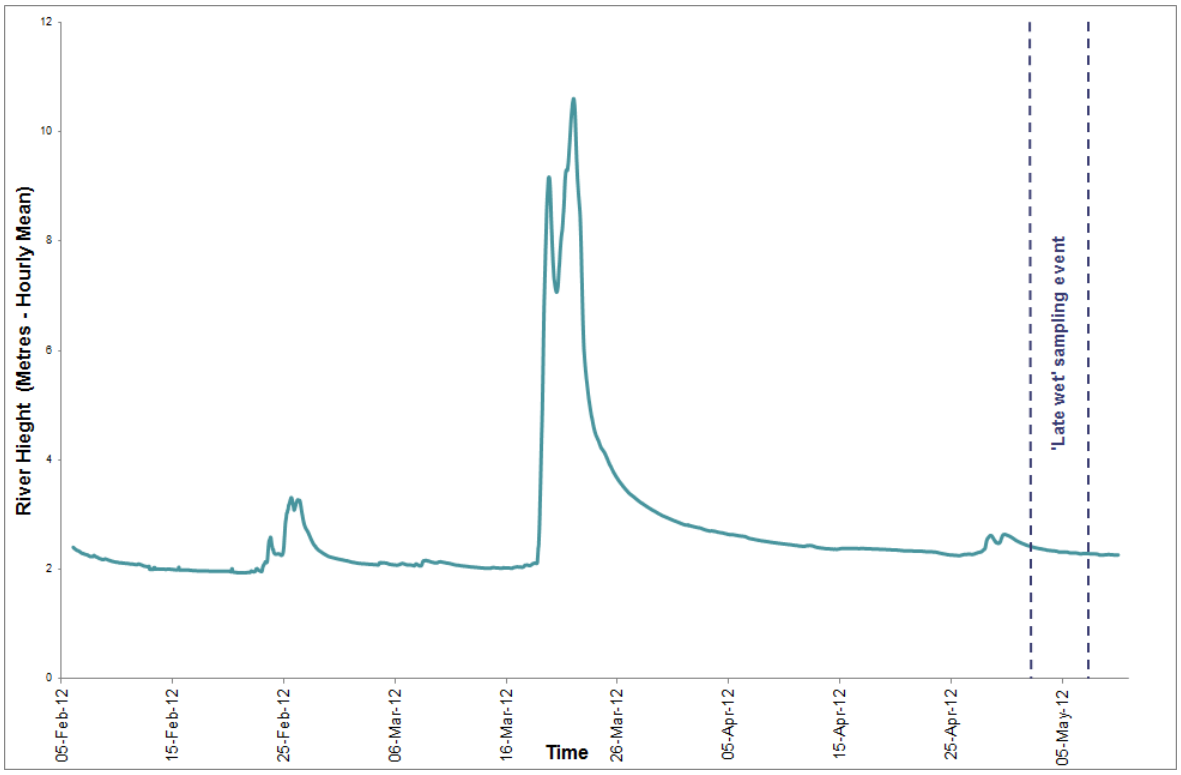

Figure 7.1 River Heights for Suttor River at Eaglefield (Data source: DERM Station No. 120304A)

7.2.2 Palustrine Wetlands

The Queensland Wetlands mapping (DERM 2011) identifies only one mapped palustrine wetland within the project area. This wetland (site S3) is situated on a closed depression of the Suttor River floodplain, and is intersected by the western boundary of the project area (**Figure 3.1**). At the time of the surveys, this wetland was a vegetated swamp covering approximately 60 ha (1 km x 0.6 km), with an average depth of 0.5 m. It was dominated by Forest red gums (*Eucalyptus tereticornis*) and emergent macrophytes (**Section 7.4**).

Surface hydrology within the catchment of this wetland has been altered by the construction of a railway line, although the extent of impacts associated with the construction of this feature are unknown. The wetland is likely to be semi-permanent in nature, given that *Eucalyptus tereticornis* is susceptible to impacts of waterlogging and is characteristic of ephemeral wetlands.

Figure 7.2 Palustrine wetland (site S3) on the western boundary of the project area, Byerwen, May 2012

7.2.3 Lacustrine Wetlands

The Queensland Wetlands mapping (DERM 2012b) identifies seven mapped lacustrine wetlands within the project area (**Figure 3.1**). Six of these are dammed drainage channels, and the seventh is a topographic depression upslope of a constructed contour in the south-eastern section of the project area. The dam to the west of East Pit 1 and 2 would remain undeveloped, as would the topographic depression. The dam near the south-east corner of South Pit 1 would be incorporated into the drainage diversion; however would remain largely unchanged.

One of the dams (site S2) is positioned within the proposed West Pit 1 (**Figure 4.1**), and would be dewatered as part of the Project. This dam had recently (in 2011) been enlarged. At the time of the surveys, the wetted area of site S2 was approximately 5 ha, being approximately 250 m wide at the dam wall, and extending approximately 400 m upstream. Fringing vegetation was dominated by Brigalow (*Acacia harpophylla*) and pasture grasses.

Figure 7.3 Lacustrine wetland (Site S2) downstream of the proposed West Pit 1, Byerwen, May 2012

Two dams located to the north of East Pit 1 would remain unaffected by the project, as would the dam located on a tributary to Suttor Creek in the far southeast of the project area.

7.2.4 Gilgai Wetlands

A number of gilgai wetlands were observed across the project area, all occurring on untilled vertosol soils (see Figure 5.1 of the Terrestrial Ecology Impact Assessment, AMEC 2012). These gilgai wetlands are ephemeral and are expected to fill with water during and following periods of heavy and/or extended rain. **Figure 7.4** shows an example of a gilgai wetland (site S5) observed within the project area during surveys in May 2012. This wetland was approximately 0.7 m deep. Perimeter vegetation was dominated by the annual herb sesbania pea (*Sesbania cannabina*), interspersed with a diversity of macrophytes including; *Juncus* sp., *Marsilea nutica*, Monochoria (*Monochoria cyanea*), *Cyperus* sp., Cumbungi (*Typha domingensis*) and Smartweed (*Persicaria attenuata*). Brigalow (*Acacia harpophylla*) regrowth dominated the gilgai mounds. Frogs, waterbirds and aquatic invertebrates were observed within this gilgai wetland.

Figure 7.4 Gilgai wetland (Site S5) and some of the fauna residing within, including fairy shrimp (*Branchinella* sp.) and freshwater crab (*Austrothelphusa transversa*), Byerwen, May 2012

7.2.5 Physical Habitat Assessment

The physical habitat variables for each of the riverine and wetland sites are presented in **Table 7.4**. Physical habitat variables and AUSRIVAS habitat thresholds for riverine sites only are presented in **Figure 7.5**. The habitat variables and categories were derived from AUSRIVAS Habitat Assessment protocols (DNRM 2001).

Table 7.4 Physical Habitat Variables of Riverine and Wetland Survey Sites in the Project area, May 2012

Habitat Variable	Suttor River and Tributaries			Kangaroo Creek Tributaries				Wetlands	
	S1	S4	S6	S7	S8	S9	S10	S2	S3
Bottom substrate/available cover	Good	Poor	Good	Good	Good	Good	Good	Poor	Poor
Embeddedness	Good	Poor	Fair	Good	Fair	Fair	Good	Good	Excellent
Velocity/depth category	Fair	Poor	Poor	Poor	Fair	Fair	Fair	Poor	Poor
Channel alteration	Fair	Excellent	Fair	Fair	Fair	Poor	Fair	NA	NA
Bottom scouring and deposition	Poor	Fair	Fair	Poor	Fair	Poor	Fair	Excellent	Excellent
Pool/riffle, run/bed ratio	Fair	Fair	Fair	Fair	Good	Fair	Good	NA	NA
Bank stability	Fair	Poor	Good	Good	Fair	Fair	Fair	Excellent	Excellent
Bank vegetative stability	Excellent	Good	Good	Good	Good	Good	Excellent	Excellent	Excellent
Streamside cover	Excellent	Excellent	Fair	Excellent	Excellent	Excellent	Excellent	Fair	Excellent

Note: NA = Not Applicable.

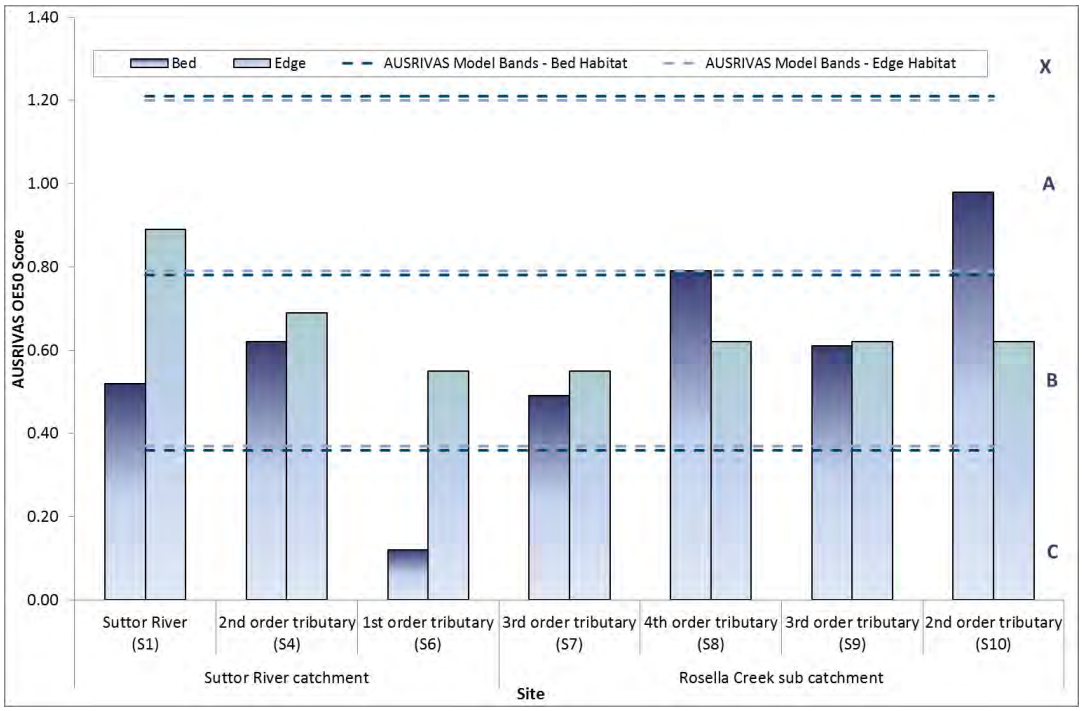

Figure 7.5 Physical habitat variables, for riverine sites, Byerwen, May 2012

The overall habitat condition of each riverine survey site was assessed as being 'fair'. Most sites exhibited excellent streamside cover. However, overall scores were reduced by factors including:

- Evidence of bottom scouring and deposition at most sites – associated with fine substrates, erodible bank materials and intense runoff having previously occurred
- Poor velocity/depth categories – with most sites containing only isolated pools and lacking runs or riffles associated with stream flow and connectivity.

The latter is largely a result of seasonality (also modified flow paths, dams, etc, with many sites dry at the time of sampling. .

7.3 WATER QUALITY

The *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZECC/ARMCANZ, 2000) are the default water quality guidelines for aquatic ecosystems in Australia.

Waterways within the project area were assessed against these guidelines using:

- Default trigger values for physical and chemical stressors for tropical Australia for slightly disturbed ecosystems
- Default trigger values for toxicants at 95% species protection level – slightly to moderately disturbed freshwater systems.

The ANZECC guidelines recommend that, where individual states or territories have developed their own regional guideline trigger values, those should be used in preference to the national guidelines.

The QWQG (DERM, 2009) have, therefore, been used where applicable. The relevant QWQG for the Project area are the Central Coast Queensland regional guideline values

for slightly to moderately disturbed waters. This includes specific water quality guidelines for both upland and lowland streams, as well as for wetlands.

According to the QWQG (DERM, 2009), upland streams are small (first, second, and third order) streams, moderate to fast-flowing due to steep gradients, and with substrates usually comprised of cobbles, gravel, or sand. Consequently, guideline values for upland streams apply to sites S4, S6, S7, S9, and S10. Conversely, the QWQG define lowlands streams as larger (third, fourth and fifth order or greater) streams, slow-flowing and meandering, with very slight gradient, and substrates which are rarely comprised of cobble and gravel, but more often of sand, silt or mud. Guideline values for lowland streams apply to sites S1 and S8. QWQG values for palustrine wetlands apply to site S3 and values for lacustrine wetlands apply to site S2 (**Table 7.5** and **Table 7.6**).

7.3.1 Physico-chemical Water Quality

Physico-chemical water quality parameters are presented in **Table 7.5** and in **Figure 7.6** and **Figure 7.7**.

Table 7.5 Physico-Chemical Water Quality Guideline Values and Measurements Obtained at Survey Sites in the Project Area, May 2012

Parameter	Guideline				Site								
	Upland Streams*	Lowland Streams^	Palustrine Wetlands^{+}	Lacustrine Wetlands^{-}	S1^	S2^{-}	S3^{+}	S4*	S6*	S7*	S8^	S9*	S10*
Temperature[5] (˚C)	7.3–40	7.3–40	7.3–40	7.3–40	21.6	24.3	22.3	18.7	22.6	19.0	21.8	24.0	16.6
pH (pH units)	6.5–7.5[a] (during flow) 5.5–9.0[a] (during flood or no flow)	6.5–8.0[a] (during flow) 5.5–9.0[a] (during flood or no flow)	6.0–8.0[b]	6.5–8.0[a]	6.8	7.1	7.5	7.0	7.6	**8.0**	7.9	**8.3**	8.2
Electrical Conductivity (µS/cm)	168[c], 271[d]	168[c], 271[d]	90–900[b]	90–900[b]	**174**	200	98	98	**655**	**729**	**1414**	145	**278**
Dissolved Oxygen (% saturation)[#]	90–110[a]	85–110[a]	90–120[b]	90–110[a]	**79**	**40**	**26**	**39**	**78**	**80**	**74**	**77**	**58**
Dissolved Oxygen (mg/L)	N/A	N/A	N/A	N/A	6.5	3.1	2.0	3.7	6.8	7.2	6.3	6.5	5.6
Turbidity (NTU)	25[a]	50[a]	2–200[b]	1–20[a]	NR	**30**	81	NR	**280**	**33**	10	**231**	**751**

Notes:
a. Queensland Water Quality Guidelines, Version 3 September 2009 (DERM 2009).
b. Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC and ARMCANZ 2000).
c. 75th percentile guideline value for streams in the Queensland salinity zone of Belyando-Suttor (DERM 2009).
d. 75th percentile guideline value for streams in the Queensland salinity zone of Burdekin-Bowen (DERM 2009).
e. Temperature range developed based on the known tolerance of freshwater fishes found in the Burdekin River catchment, excluding temperature cues required for spawning (Pusey *et al* 2004).

NR = Not Recorded (outside the calibrated range of water quality meter).
N/A = Not Available.
= Note that DO guidelines (% saturation) for freshwaters only apply to flowing waters, including those with significant sub-surface flows. Stagnant pools in intermittent streams naturally experience values of DO below 50% saturation (DERM 2009 – Section 3.1.1).
Highlighted in bold and shaded cells denote values that exceed relevant guidelines.
*, ^, $^{+}$ and $^{-}$ match sites to the relevant guideline.

Temperature

Water temperatures ranged from 16.6°C at site S10 (a second order tributary of Kangaroo Creek) through to 24.3°C at site S2 (a dam on a tributary of the Suttor River). However, it is important to note that water temperatures depend on the time of day of sampling, and are also affected by shading, depth, flow conditions, recent inflow, and aquatic flora coverage at individual sites.

At present there is no guideline for water temperature within the QWQG or ANZECC/ARMCANZ guidelines. However, a broad guideline range of 7.3 to 40°C is provided in **Table 7.5** based on the known temperature tolerance of freshwater fishes found in the Burdekin River catchment (Allen *et al.* 2002; Pusey 2004). The measured temperatures of all sites fall within this range.

pH

In situ pH levels ranged from 6.8 (neutral) at site S1, to 8.3 (moderately alkaline) at site S9. pH levels exceeded the relevant QWQG range of 6.5 to 7.5 for upland streams in times of flow, the sites S7 and S9 (**Figure 7.6**). At the time of sampling, stream flows at both of these sites appeared to be receding. When these ephemeral streams cease to flow, the guideline range for pH in standing pools would be increased to 5.5 to 9.0 (DERM 2009).

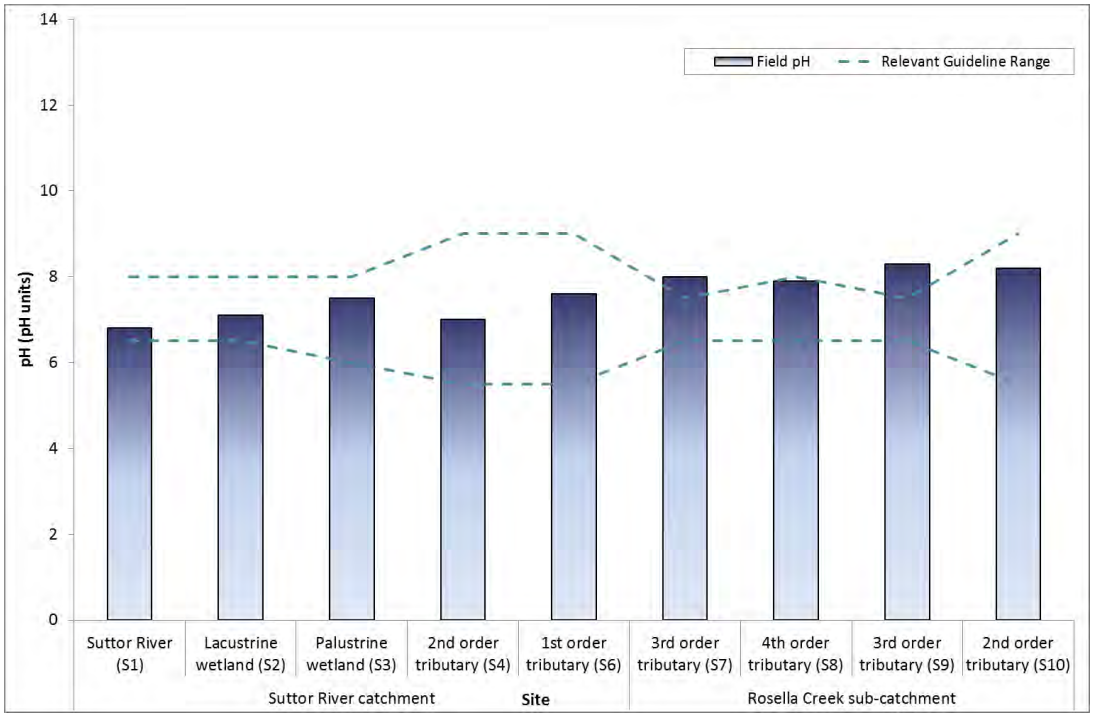

Figure 7.6 pH recorded at survey sites in the project area, May 2012

The pH levels appear to differ between sites in the Suttor River sub-catchment and those of the Kangaroo Creek sub-catchment. This may be indicative of differing geology across the two sub-catchments.

Electrical Conductivity (EC)

The EC levels were variable across the project area, ranging from the 98 µS/cm (fresh) at sites S3 and S4, to 1414 µS/cm (moderately saline) at site S8. The EC levels exceeded the relevant guideline values at sites S1 and S6 in the Suttor River sub-catchment, and at

sites S7, S8, and S10 in the Kangaroo Creek sub-catchment (**Figure 7.7**). Site S6 receives run-off from a coal haul road to the east (**Figure 3.1**) and consisted of drying pools in which concentrating salts were expected and observed. The catchment of site S8 appears (from aerial imagery) to contain areas of natural scalds within, and to the west of the project area (**Figure 3.1**). The local geology and associated soils of this catchment are the most likely contributors to the moderately saline runoff observed.

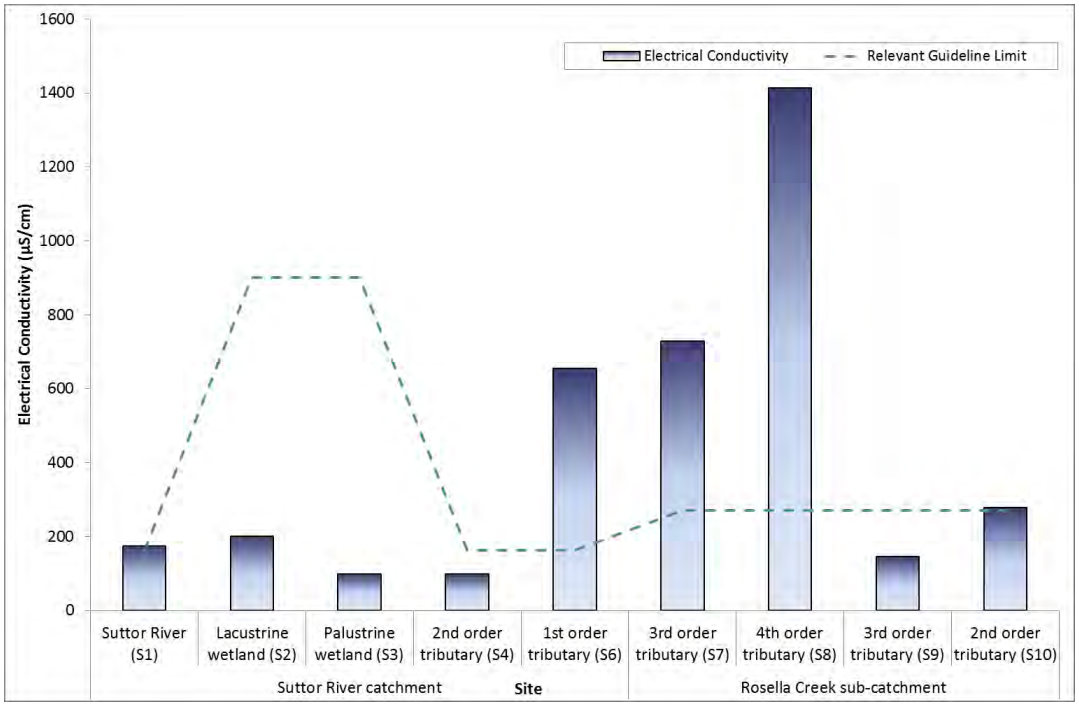

Figure 7.7 Electrical conductivity at survey sites in the Project area, May 2012

Dissolved Oxygen (DO)

The DO concentrations were relatively low across the project area, with poorly oxygenated conditions recorded at sites S2 (40% saturation, or 3.1 mg/L), S3 (26% saturation, or 2.0 mg/L) and S4 (39% saturation, or 3.7 mg/L) (**Figure 7.8**). The DO concentrations fell below the relevant guideline range (**Table 7.5**) at each site; however, the guidelines recognise that stagnant waters naturally experience values of DO below 50% saturation (DERM 2009).

The low DO concentrations are indicative of the low to nil flow conditions, which were observed across the project area. The DO levels are expected to decline further over the dry season, as flows are expected to cease at all sites, and waterways likely to senesce into drying pools where oxygen will be consumed by decomposing organic matter. When flows return in the wet season, DO levels are expected to increase.

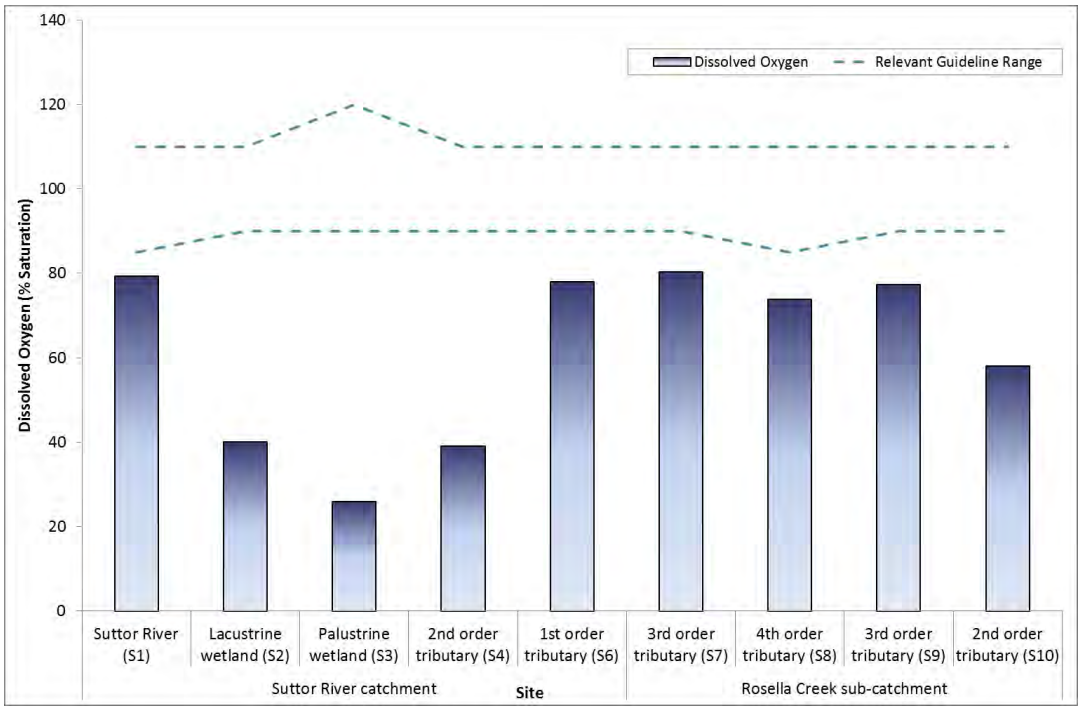

Figure 7.8 Dissolved oxygen levels at survey sites in the project area, May 2012

Turbidity

Turbidity (NTU) was variable across the project area, ranging from 10 NTU at site S8, to over 800 NTU at sites S1 and S4 (**Figure 7.9**). Turbidity was relatively low at the wetland sites, and higher at sites which exhibited flow, and/or where cattle had direct access to the waterway, causing surface erosion. High turbidity is expected in most waterways of the project area (and the broader catchment), where stream banks and beds consist of high percentages of silt and clay, which are more readily held in suspension.

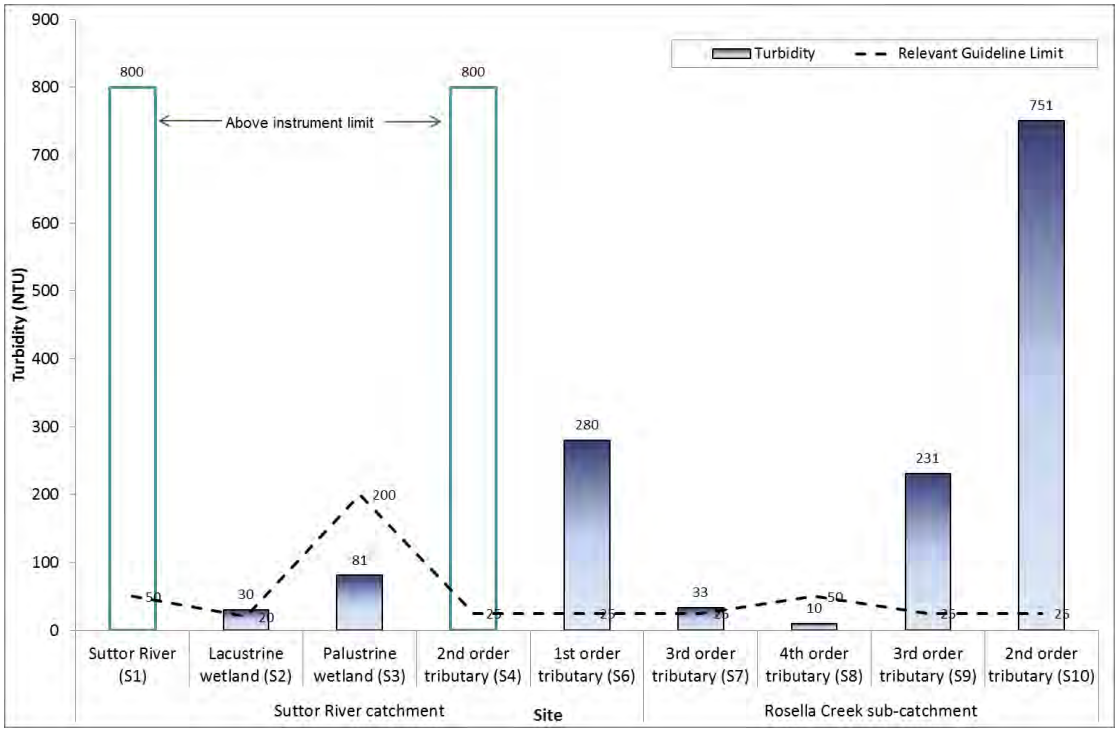

Figure 7.9 Turbidity levels at Survey sites in the Project area, May 2012

7.3.2 Nutrients

Nutrient concentrations in samples collected from the survey sites, plus relevant guidelines values, are presented in **Table 7.6**. The laboratory analyses results are provided in **Attachment C**.

Total Nitrogen (TN) concentrations exceeded guideline criteria at sites S1, S2, S4, S5, S6, S7, S9, and S10, while TN concentrations were below guideline criteria at sites S3 and S8. TN concentrations ranged from 0.3 mg/L at sites S7 and S8 to 1.2 mg/L at site S2 (the lacustrine wetland/farm dam). Ammonia concentrations (NH_3 as N) exceeded the guideline criteria in all sites, except site S3. Ammonia concentrations ranged from 0.04 to 0.1 mg/L (**Table 7.6**).

TN was dominated by Kjeldahl forms of nitrogen (TKN), which is the sum of organic nitrogen, ammonium, and ammonia (**Table 7.6**). Organic nitrogen is not immediately available for biological activity, such as algae and plant growth; however, ammonia is. Subtraction of ammonia concentrations from TN concentrations indicates that all samples were dominated by either organic nitrogen or ammonium. Ammonium and ammonia exist in an equilibrium which shifts with pH, such that ammonia concentrations increase with increasing pH. Unlike ammonium, ammonia is highly toxic to aquatic life and when pH exceeds 9, fish fatalities may occur (Boulton and Brock 1999). As pH levels were found to be below 8.5 at each site, the observed NH_3 concentrations are not considered to be problematic.

Table 7.6 Surface Water Nutrients at Survey sites in the Project area, May 2012

Parameter	Guideline				Site								
	Upland Streams*	Lowland Streams^	Palustrine Wetlands+	Lacustrine Wetlands-	S1^	S2-	S3+	S4*	S6*	S7*	S8^	S9*	S10*
Nitrite as N (mg/L)	N/A	N/A	N/A	N/A	<0.01	<0.01	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	0.01
Nitrate as N (mg/L)	N/A	N/A	N/A	N/A	0.04	<0.01	<0.01	0.14	0.01	0.02	0.01	0.02	0.14
Nitrite + Nitrate as N (mg/L)	0.015[a]	0.06[a]	0.01[b]	0.01[a]	0.04	<0.01	<0.01	0.15	0.01	**0.02**	0.01	**0.02**	0.15
Total Kjeldahl Nitrogen as N (mg/L)	N/A	N/A	N/A	N/A	0.7	1.2	0.9	0.8	0.8	0.3	0.3	0.6	0.6
Ammonia as N (mg/L)	0.01[a]	0.02[a]	0.9[b]	0.01[a]	**0.06**	**0.05**	0.05	**0.10**	**0.05**	**0.04**	**0.04**	**0.05**	**0.06**
Total Nitrogen (mg/L)	0.25[a]	0.5[a]	0.35-1.2[b]	0.35[a]	**0.7**	**1.2**	0.9	**1.0**	**0.8**	**0.3**	0.3	**0.6**	**0.8**
Reactive Phosphorus (mg/L)	0.015[a]	0.02[a]	0.005–0.025[b]	0.005[a]	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Total Phosphorus (mg/L)	0.03[a]	0.05[a]	0.01–0.05[b]	0.01[a]	**0.08**	**0.13**	**0.12**	**0.54**	**0.13**	<0.01	**0.06**	**0.12**	0.02

Notes:
a. Queensland Water Quality Guidelines, Version 3 September 2009 (DERM 2009).
b. ANZECC and ARMCANZ (2000) – Australian and New Zealand Guidelines for Fresh and Marine Water Quality – Tropical Australia (Table 3.3.4).
c. ANZECC and ARMCANZ (2000) – Australian and New Zealand Guidelines for Fresh and Marine Water Quality – 95% level of species protection (Table 3.4.1).
* = upland stream sites
^ = lowland stream sites
+ = palustrine wetland sites
- = lacustrine wetland sites
Highlighted in bold and shaded cells denote values that exceed relevant guidelines.

Concentrations of nitrogen oxides (NOx, or nitrate + nitrite as N) exceeded the nominated guideline criteria of 0.015 mg/L at sites S7 (0.02 mg/L) and S9 (0.02 mg/L), both of which are within the Kangaroo Creek catchment. Concentrations of NOx were equal to the nominated guideline criteria of 0.015 mg/L at sites S4 and S10. All other sites were below nominated NOx guideline criteria, or below laboratory limits of reporting.

Nitrate (as N) was detected at all sites except S2 and S3. While nitrite (as N) was below laboratory limits of reporting at all sites. Oxidised nitrogen in the form of nitrate-nitrogen (NO_3-N), is less toxic to aquatic life than its reduced forms such as nitrite-nitrogen (NO_2-N) and ammonia (NH_3).

Comparison of results for Total Phosphorus (TP) and reactive (or available) phosphorus indicate that most of the phosphorus is unavailable and is likely bound to silt and clay particles held in suspension. Phosphorus is a component of nucleic acids and a universal energy molecule (adenosine triphosphate – ATP) and is therefore essential to all life. Most natural waters contain phosphorus in various forms.

High nutrient concentrations (nitrogen and phosphorus) can indicate the potential for excessive weed and algal growth (DERM 2009). However, this depends on the bioavailability of nutrients, as well as physical characteristics of the waterway, such as turbidity which can reduce light penetration beneath the water's surface, decreasing photosynthetic rates, and associated weed and algal growth.

7.3.3 Ionic Composition

The results of the major cation and anion analyses are presented in **Table 7.7**, with relative compositions presented in **Figure 7.10**.

The relative ionic composition of samples collected across the project area was variable. Sodium concentrations far exceeded concentrations of all other cations at all sites, except site S2, where calcium concentrations were higher. Concentrations of calcium and magnesium were also high, although not higher than sodium, at sites S6, S7, and S8. Potassium concentrations were low at all sites.

Anionic composition was dominated by alkalinity at six of the nine sampling sites, while chloride was dominant at sites S1 and S10, and sulphate was dominant at site S6.

The sulfate dominant anions at S6 (a first order tributary of the Suttor River) were likely a result of sulfate rich runoff from an existing coal haul road, approximately 500 m upstream of site S6. Sulfate concentrations at site S6 may have been exacerbated by the drying conditions, which reduced water levels and likely led to ions concentrating in the drying pools. However, the detected level of 111 mg/L was well below the upper guideline value of 1000 mg/L for stock watering, and below the guideline value of 400 mg/L for general use, recreational, and raw water supply (ANZECC/ARMCANZ 2000).

Table 7.7 Results of Major Cation and Anion Analyses of Surface Waters Collected from Survey Sites in the Project Area, May 2012

Parameter		Site								
		S1	S2	S3	S4	S6	S7	S8	S9	S10
Major Cations (mg/L)	Calcium (Ca)	4	15	2	5	30	29	61	3	11
	Magnesium (Mg)	5	7	2	3	19	37	64	4	6
	Sodium (Na)	25	9	14	14	70	55	101	13	25
	Potassium (K)	2	7	3	2	6	3	5	2	3
Major Anions (mg/L)	Chloride (Cl)	31	6	11	8	86	52	174	15	37
	Sulfate (SO_4)	<1	<1	<1	<1	111	<1	<1	<1	<1
	Alkalinity (HCO_3 + CO_3)	38	88	30	50	82	273	448	28	51

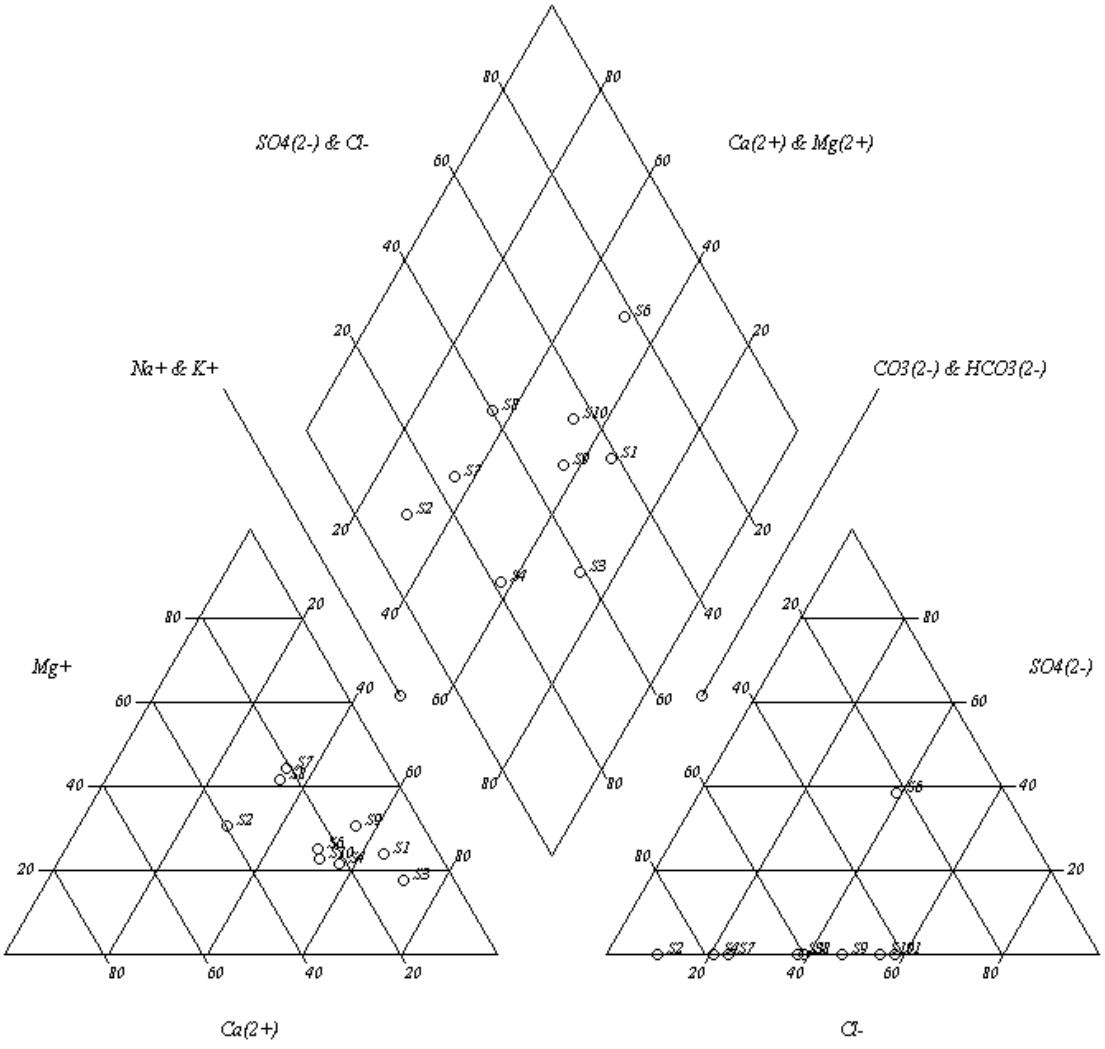

Figure 7.10 Ionic composition of surface waters (major cations and anions) at survey sites in the project area, May 2012

7.4 FLORA SURVEY RESULTS

A total of 13 genera of aquatic plants (macrophytes) were recorded during the survey. Three ACA Priority species were recorded at site S3 and are indicated in bold text in the Table 7.8 below.

Table 7.8 Macrophytes Recorded at Survey Sites in the Project area, Byerwen, May 2012

Scientific Name	Common Name	Site									
		S1	S2	S3	S4	S5	S6	S7	S8	S9	S10
Cyperus spp.	Sedges	✓		✓	✓	✓		✓			✓
*Echinochloa colona**	Awnless barnyard grass			✓			✓				✓
Eclipta prostrata	White eclipta						✓				
Eleocharis dulcis	**Water chestnut**			✓							
Eleocharis equisetina	Spike rush			✓							
Juncus spp.	Common rush					✓				✓	
Leersia hexandra	**Swamp ricegrass**			✓							
Marsilea drummondii	**Nardoo**			✓							
Marsilea mutica	Marsilea			✓		✓					
Monochoria cyanea	Monochoria			✓		✓					
Nymphoides crenata	Wavy marshwort			✓							
Persicaria attenuata	Smartweed		✓			✓					
Philydrum lanuginosum	Frogsmouth			✓							
Typha domingensis	Cumbungi					✓					
Utricularia aurea	Bladderwort			✓							

Notes:
Bold text denotes ACA priority species (Inglis and Howell 2009a; 2009b) identified in **Section 7.1.3**.
* Denotes introduced species.

All wetland indicator plants were of emergent growth form, with the exception of bladderwort (*Utricularia aurea*), which is a submergent form.

The palustrine wetland (site S3), and gilgai wetland (site S5), had the highest diversity of macrophytes (**Table 7.8**). The lacustrine wetland (site S2) and the stream survey sites (sites S1, S4, S6, S7, S8, S9 and S10) all had low macrophyte diversity and abundance. No macrophytes were recorded at site S8, a fourth order tributary of Kangaroo Creek (**Figure 7.11**).

The lack of both diversity and abundance in macrophyte cover at the stream survey sites may be indicative of the harsh physical conditions, scouring, and sediment movement

associated with the high flow and flood events that occurred in the broader project area in early 2012 (**Section 7.2.1**). However, the lack of diversity may also be due to seasonal variation. Seasonal conditions may influence the diversity and/or abundance of macrophytes. For example, community variation may occur through recruitment in response to sustained flows, or through increased temperatures and daylight hours in the warmer months. It should be noted that a further 'early wet' season survey was completed in December 2012, for which results are not available.

Figure 7.11 Survey sites with the highest diversity (site S3 – left) and lowest diversity (site S8 – right) of Macrophytes, May 2012

Species of Conservation Significance

No threatened aquatic flora species, or genera containing threatened aquatic flora species, were identified within the project area during the May 2012 survey. Neither of the two threatened aquatic flora species identified in database searches as occurring in the broader Burdekin basin are likely to occur in the project area. (**Table 7.1**).

Three Priority flora species were detected within the palustrine wetland (site S3). **Section** 8 provides recommendations for avoiding both direct and indirect impacts on this wetland.

Aquatic Weeds

Only one aquatic weed, Awnless barnyard grass (*Echinochloa colona*), was detected during field surveys, it is a weed of irrigated areas and soils prone to flooding, at sites S3 and S6. This species is a native of tropical Africa and Asia. It is not listed as a weed of national significance, (WONS) in Australia, nor is it declared under the Queensland LP Act.

No other aquatic (or semi-aquatic) weeds were identified during the field survey.

7.5 FAUNA SURVEY RESULTS

7.5.1 Macroinvertebrates and Stream Health

Taxonomic Composition

A total of 1,342 individuals, representing 57 taxa, were retrieved from the 18 samples collected during field surveys. All individuals were subsequently identified to the required AUSRIVAS taxonomic level, (**Section 6.3.5**). Full results of taxonomic classification of all individuals collected are included in **Attachment D**.

Edge habitat at all surveys sites had higher taxa richness than bed habitats (**Figure 7.12**). Site S3 had the highest taxa richness, while the bed habitat of site S6 had the lowest (**Figure 7.12**).

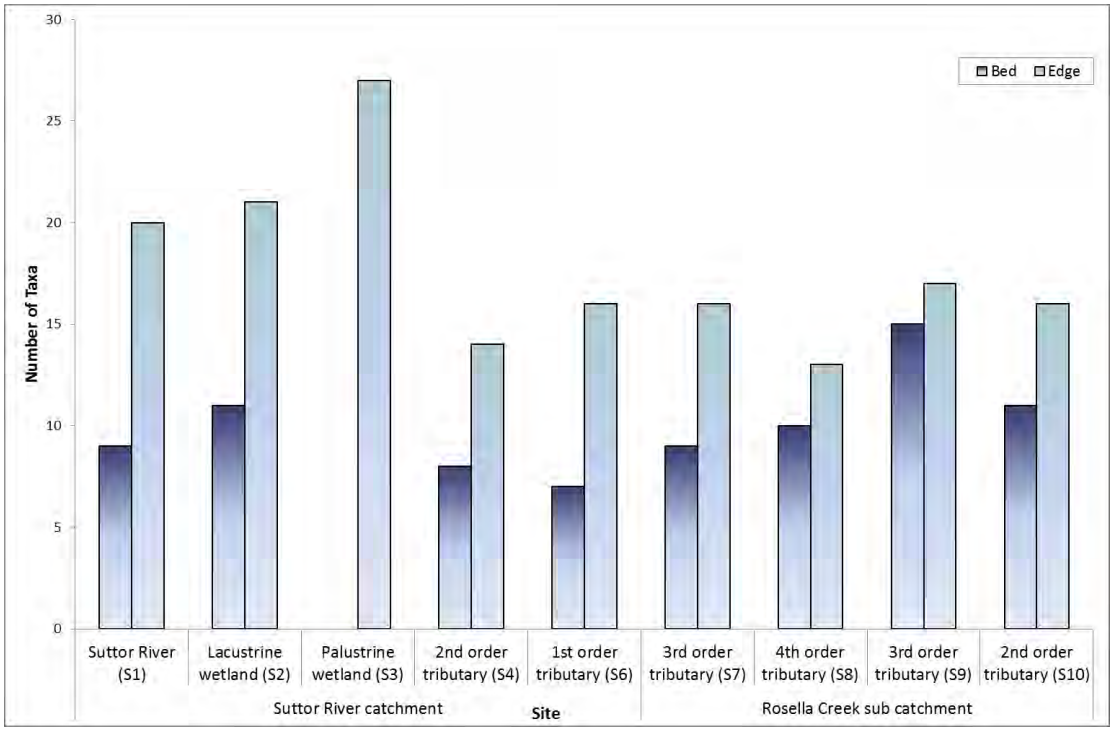

Figure 7.12 Macroinvertebrate taxa richness at survey sites in the project area, May 2012

SIGNAL 2 Results

SIGNAL 2 scores ranged from 2.75 in the bed habitat at site S6, to 4.22 in the bed habitat at site S7 (**Figure 7.13**). The SIGNAL 2 score showed no pattern between bed and edge habitat, with scores higher for the edge habitat at sites S1, S7, S8 and S10 and higher for the bed habitat at sites S4, S6 and S9.

Both bed and edge habitat at site S1, and bed habitat at sites S7 and S10, had SIGNAL 2 scores above 4, which indicates a moderately polluted habitat. Bed and edge habitats at sites S4, S6, S8, S9, and edge habitats at site S7 and S10, had SIGNAL 2 scores lower than 4, which indicates more severely polluted habitat. SIGNAL 2 results within the project area are relatively low, indicating that a greater proportion of pollution tolerant taxa are present at survey sites.

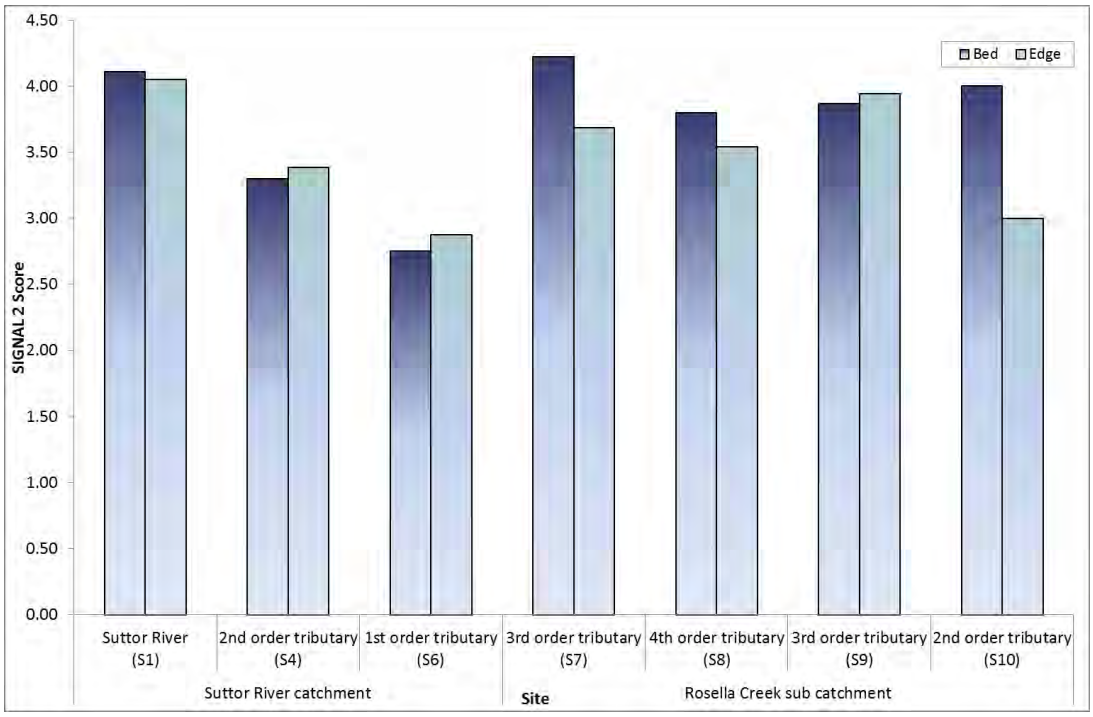

Figure 7.13 SIGNAL 2 results for survey sites in the project area, May 2012

The relationships between taxa richness of macroinvertebrates and SIGNAL 2 scores were displayed using a bi-plot, divided into 4 quadrants, each quadrant indicative of particular conditions (**Figure 7.14**). Quadrant boundaries are set according to study locations. For the present study, boundaries were set using the Central Coast Queensland regional guidelines values for biological indicators (slightly to moderately disturbed water) as provided in the QWQG (DERM, 2009). These guidelines state, a taxa richness of 33 and SIGNAL 2 value of 4.20 apply to the edge habitat, and a taxa richness of 21 and a SIGNAL 2 value of 3.85 apply to the bed habitat. All guidelines are based on the 80th percentile. It should be noted that the area related to these guideline values, the Central Coast Queensland region, includes 19 basins. These basins extend north from the Burnett River basin to the Black River basin. A large range of variability in stream health is expected across this area. Sub-regional guidelines for the Burdekin Basin, when developed, may be substantially different.

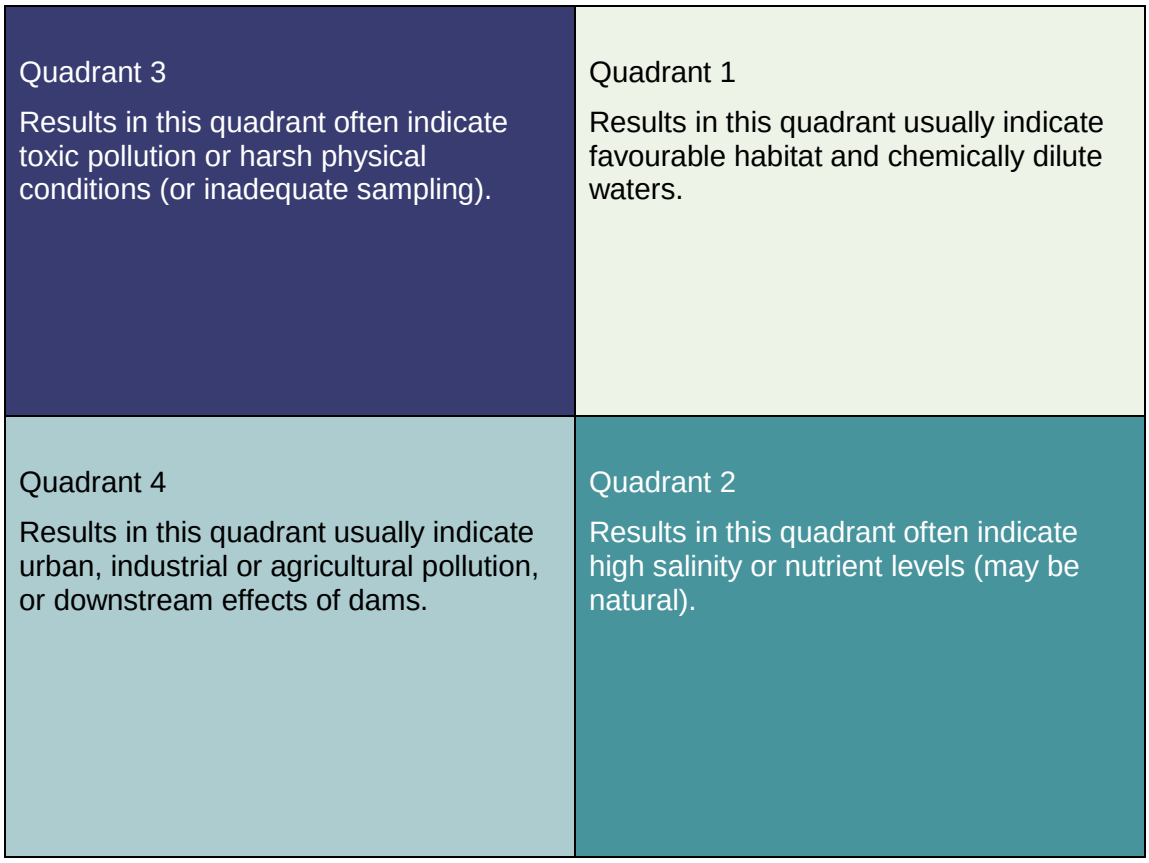

Figure 7.14 The quadrant diagram for the family version of SIGNAL 2 (Chessman, 2003)

Bi-plots are shown in **Figure 7.15** and **Figure 7.16** for bed and edge habitats, respectively. No samples fell within quadrant 1 or quadrant 2. The samples collected from the bed habitat of sites S1, S7, S9 and S10 fell within quadrant 3. Sites within quadrant 3 often display effects of toxicity such as low pH or high concentrations of trace metals. Macroinvertebrates at these sites are often tolerant of pollution. All edge samples, as well as the bed samples collected from sites S2, S4, S6, and S8, fell within quadrant 4. Sites falling within quadrant 4 are generally considered to be suffering from one or more forms of human impact such as urban, industrial or agricultural impacts or downstream effects of dams.

The results of the bi-plots suggest that most of the sites have been under long-term stress from decreased water quality (possibly natural or from past and present land uses), harsh physical conditions (intense seasonal runoff and erosion and deposition and fine sediments) or other anthropogenic effects.

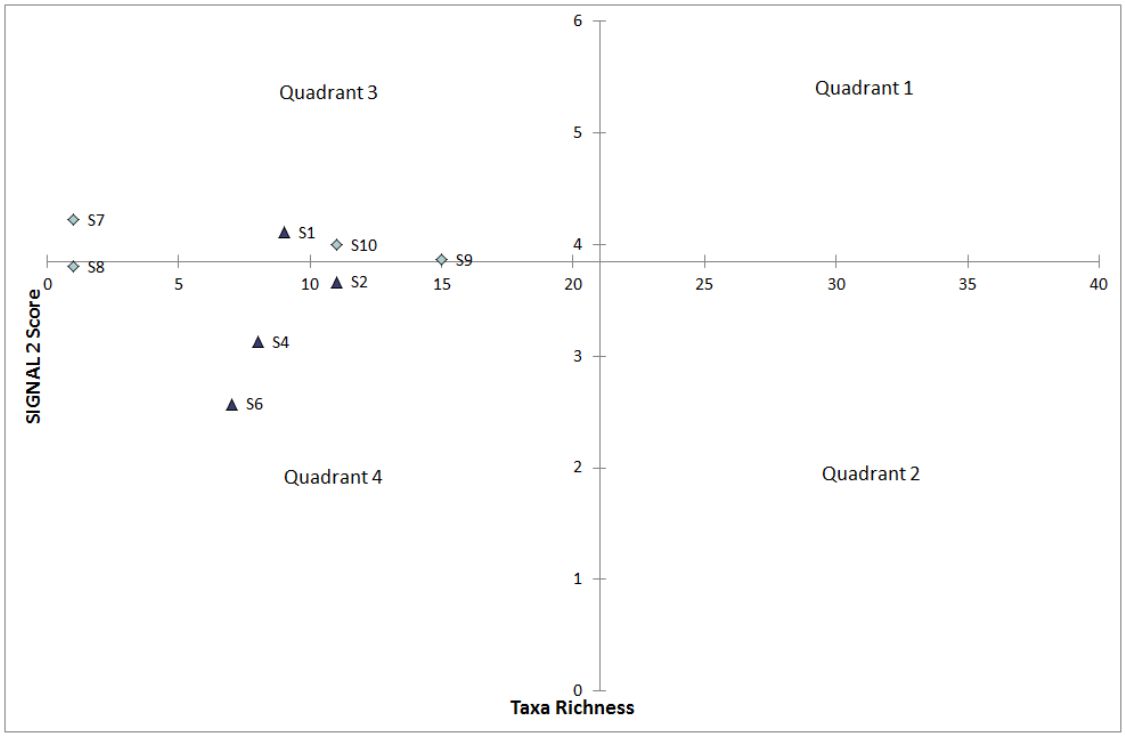

Figure 7.15 Relationship between bed taxa richness and SIGNAL 2 scores for survey sites in the project area, May 2012

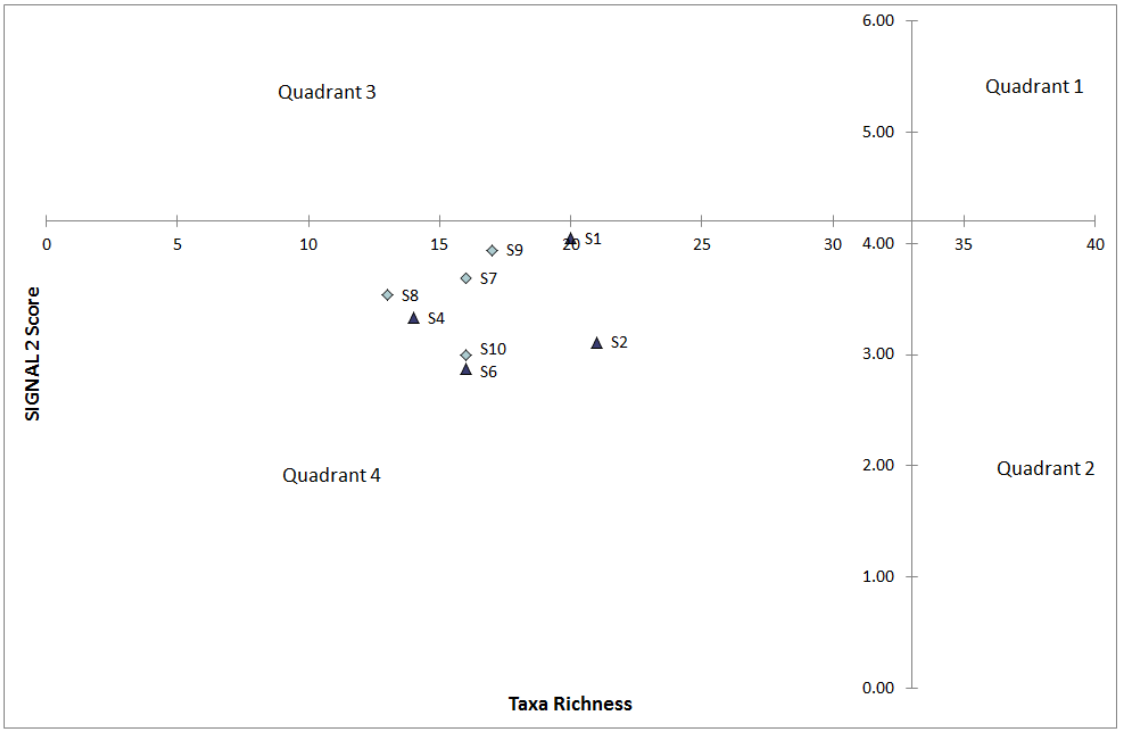

Figure 7.16 Relationship between edge taxa richness and SIGNAL 2 score for survey sites in the project area, May 2012

AUSRIVAS Model Outputs

Macroinvertebrate data was modelled using the AUSRIVAS (Queensland Regional – Coastal – Autumn) model for the habitats sampled. The bandwidth for these models is provided in **Table 7.9**.

Table 7.9 Bandwidths for Queensland Regional – Coastal – Autumn – bed and edge AUSRIVAS Models

Band Label	Upper Limit (Bed)	Upper Limit (Edge)	Band Name	Band Description
Band X	Infinite	Infinite	More biologically diverse than reference sites	More taxa found than expected. Potential biodiversity hot-spot. Possible mild organic enrichment.
Band A	1.21	1.20	Reference condition	Most/All of the expected families found. Water quality and/or habitat condition roughly equivalent to reference sites. Impact on water quality and habitat condition does not result in a loss of macroinvertebrate diversity.
Band B	0.78	0.79	Significantly impaired	Fewer families than expected. Potential impact either on water quality or habitat quality, or both, resulting in loss of taxa.
Band C	0.36	0.37	Severely impaired	Many fewer families than expected. Loss of macroinvertebrate biodiversity due to substantial impacts on water and/or habitat quality.
Band D	0	0	Extremely impaired	Few of the expected families remain. Extremely poor water and/or habitat quality. Highly degraded.

AUSRIVAS O/E50 scores (**Figure 7.17**) indicate that most sites surveyed within the project area fell within Band B, referred to as being significantly impaired and lacking in some species that would be expected to occur at the site. The edge habitat at site S1, and the bed habitat at site S10, fell within Band A, which is considered to be roughly equivalent to reference condition. The bed habitat at site S6 fell within Band C, referred to as severely impaired due to substantial impacts on water and/or habitat quality (**Figure 7.17**).

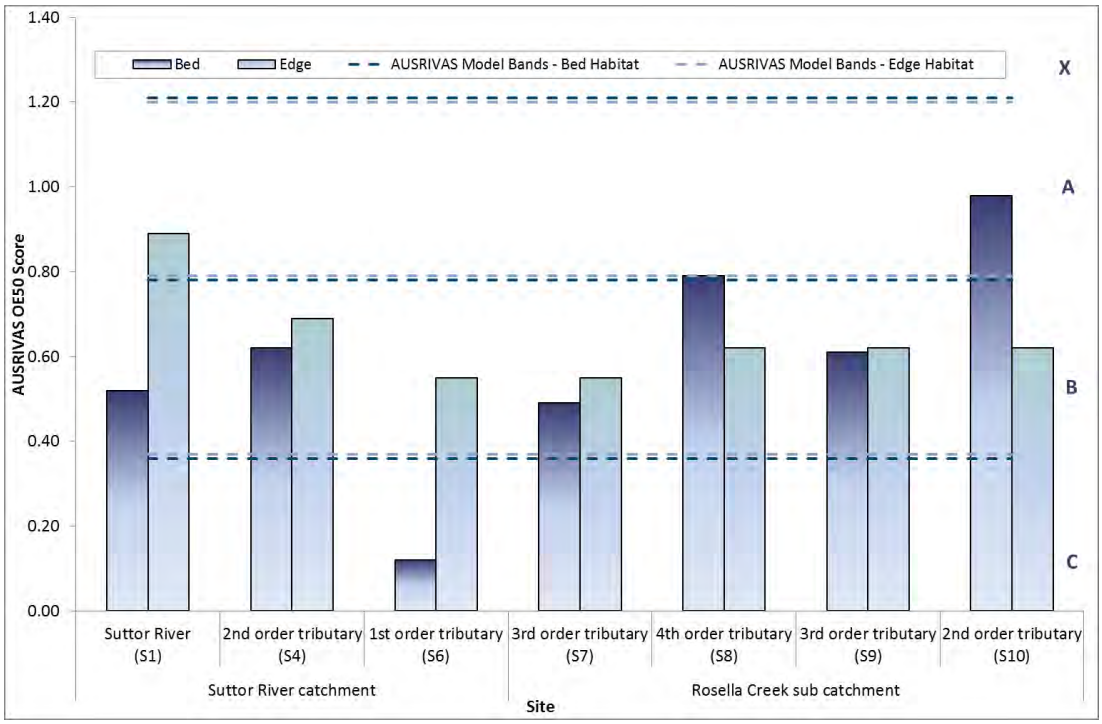

Figure 7.17 AUSRIVAS scores for stream survey sites in the project area (excludes wetland sites), May 2012

EPT Richness

The percentages of EPT taxa are shown in **Figure 7.18** and **Figure 7.19** for bed and edge habitats, respectively. Taxa from the order Plecoptera (stoneflies) were not collected at any site. Samples from the bed habitats generally exhibited a higher percentage of EPT taxa compared to edge samples, with the highest percentage of EPT taxa (28.5%) observed in the bed sample of site S7 (**Figure 7.18**). Both Ephemeroptera (mayflies) and Trichoptera (caddis flies) were collected in the all bed samples, with the exception of site S6 where no EPT taxa were recorded. While in edge samples Ephemeroptera (mayflies) and Trichoptera (caddis flies) were collected at sites S1, S2, S3, S8, S9 and S10 (**Figure 7.19**). Only one order of EPT taxa (i.e., Ephemeroptera - mayflies) was collected in the edge sample of sites S4, S6 and S7 (**Figure 7.19**). A breakdown of EPT taxa collected at each survey site by family is included in **Table 7.10**.

Bed samples from upstream sites showed lower percentages of EPT taxa compared with downstream sites within both the Suttor River sub-catchment and Kangaroo Creek sub-catchment (**Figure 7.18**).

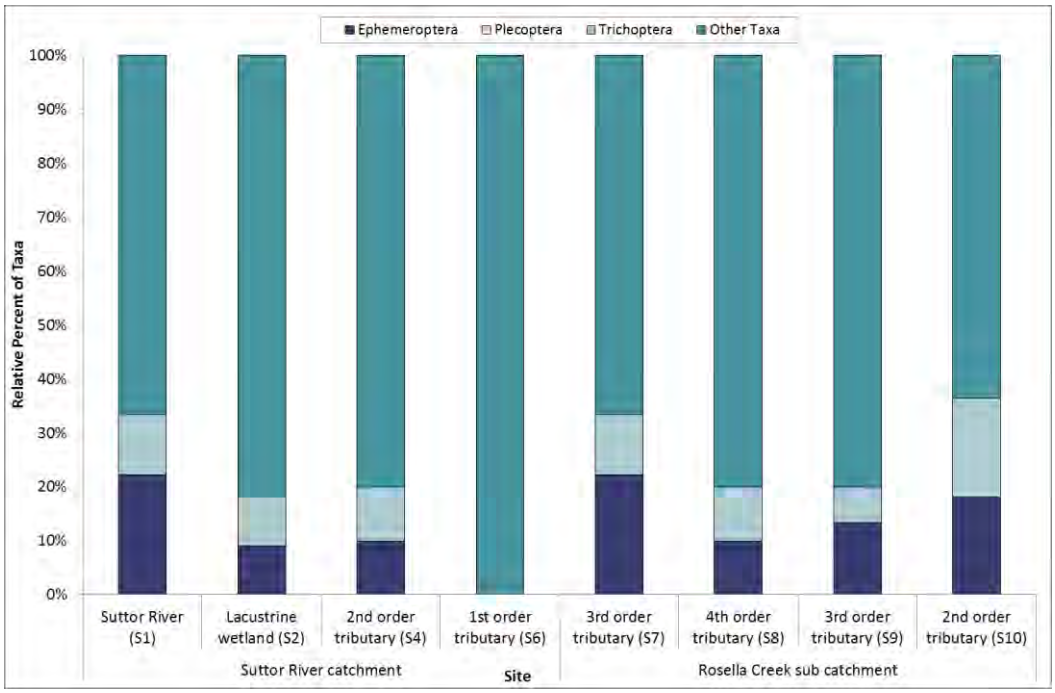

Figure 7.18 Comparison of EPT taxa for the bed habitat of survey sites in the project area, May 2012

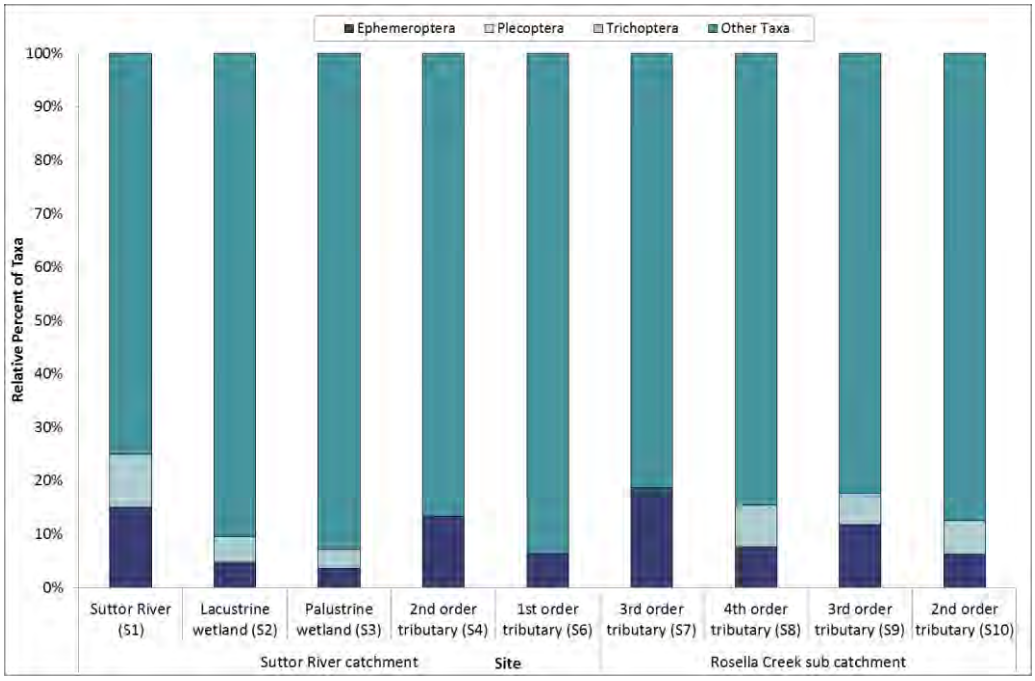

Figure 7.19 Comparison of EPT taxa for the edge habitat of survey sites in the project area, May 2012

Table 7.10 EPT Taxa collected from Survey Sites in the Project area, May 2012

Sub-catchment	Site	Site Description	Ephemeroptera	Trichoptera

			Baetidae	Caenidae	Leptophlebiidae	Ecnomidae	Hydropsychidae	Leptoceridae
Bed Samples								
Suttor River	S1	Suttor River	✓	✓			✓	
	S2	Lacustrine Wetland	✓				✓	
	S4	2nd order Tributary		✓				✓
	S6	1st order Tributary						
Kangaroo Creek	S7	3rd order Tributary		✓	✓			✓
	S8	4th order Tributary		✓		✓		
	S9	3rd order Tributary		✓	✓		✓	
	S10	2nd order Tributary	✓	✓		✓		✓
Edge Samples								
Suttor River	S1	Suttor River	✓	✓	✓		✓	✓
	S2	Lacustrine Wetland	✓					✓
	S3	Palustrine Wetland	✓					✓
	S4	2nd order Tributary	✓	✓				
	S6	1st order Tributary		✓				
Kangaroo Creek	S7	3rd order Tributary	✓	✓	✓			
	S8	4th order Tributary		✓				✓
	S9	3rd order Tributary		✓	✓			✓
	S10	2nd order Tributary		✓				✓

7.5.2 Fish

Fish species recorded at each survey site are shown in **Table 7.11**. Eight species of fish were recorded within the reaches surveyed, and were generally restricted to the available pool habitats within these reaches. All eight fish species have previously been recorded in the broader Burdekin basin (**Section 7.1.4**).

No threatened (or near threatened) species listed under Commonwealth or State legislation were found within the project area. One Priority species, the southern purple-spotted gudgeon (*Mogurnda adspersa*) (**Figure 7.20**) was recorded at sites S1, S3, and S4 in the Suttor River sub-catchment.

Figure 7.20 Southern purple-spotted gudgeon (*Mogurnda adspersa*)

The majority of fish were captured with seine and fyke nets. Bait traps did not prove an effective method of capture during surveys. As previously discussed (**Section 6.3.5**) electrofishing techniques were only employed at site S2, where one species (Rendahl's catfish – *Porochilus rendahli*) was caught using this method. **Attachment A** indicates the method(s) of survey for fish captured at each site.

Table 7.11 Fish Species recorded at survey sites in the Project area, May 2012

Scientific Name	Common Names	Site								
		S1	S2	S3	S4	S6	S7	S8	S9	S10
Ambassis agassizii	Agassiz's glassfish	✓	✓	✓	✓	✓				
Amniataba percoides	Barred grunter	✓			✓					
Hypseleotris species 1	Midgley's carp gudgeon		✓			✓				
Leiopotherapon unicolor	Spangled perch	✓		✓	✓	✓		✓		✓
Melanotaenia splendida	Eastern rainbowfish	✓		✓	✓	✓		✓		✓
Mogurnda adspersa	**Southern purple-spotted gudgeon**	✓		✓	✓					
Neosilurus hyrtlii	Hyrtl's tandan					✓				
Porochilus rendahli	Rendahl's catfish	✓	✓							

Note: **Bold** text denotes ACA Priority species' (Inglis and Howell 2009a, 2009b) identified in **Section 7.1.4**.

All eight species (**Table 7.11**) were recorded from survey sites in the Suttor River sub-catchment (sites S1, S2, S3, S4, and S6). Only two of these species, the eastern rainbowfish (*Melanotaenia splendida*), and spangled perch (*Leiopotherapon unicolor*), were recorded from the Kangaroo Creek sub-catchment (sites S7, S8, S9 and S10). Both of these species have been collected from waterways across Queensland displaying a wide range of water quality conditions (Pusey *et al.*, 2004), indicating a general tolerance to environmental degradation or harsh physical conditions.

The southern purple-spotted gudgeon (*Mogurnda adspersa*) was recorded at three sites in the Suttor River sub-catchment. This species is considered a Priority for conservation by Inglis and Howell (2009a, 2009b) due to declining populations and local extinctions occurring in the broader Burdekin basin.

7.5.3 Turtles

No turtles were observed or caught, during field surveys in May 2012. However, dams throughout the project area are likely to provide suitable habitat for turtles, including breeding habitat, and dry season refuge. This includes site S2. The waterways and gilgai wetlands of the project area, although limited by their ephemeral nature, may provide limited habitat for turtles during wetter times of the year. The palustrine wetland (site S3) may also provide habitat for turtles, although its shallow depth, lack of open water areas and dense emergent macrophytes would limit its use.

Five turtles have been recorded from the broader Burdekin basin, including Cann's longneck turtle (*Chelodina canni*), eastern snake-necked turtle (*C. longicollis*), Irwin's turtle (*Elseya irwini*), Krefft's river turtle (*Emydura macquarii krefftii*), and the saw-shelled turtle (*Wollumbinia latesternum*) (DERM 2012a). Four of these five species (all 'Least Concern' under the NC Act) may occur in the project area. It is unlikely that Irwin's turtle would occur in the project area (**Section 7.1.4**).

8. POTENTIAL IMPACTS AND MITIGATION MEASURES

Impacts and mitigation measures are provided separately for the three project phases - construction, operation and decommissioning.

8.1 CONSTRUCTION PHASE

The construction of mine infrastructure on the project area has the potential to impact on aquatic ecological values through:

- Direct removal of aquatic habitat by diverting natural waterways (stream diversions)
- Direct removal of aquatic habitat by de-watering lacustrine wetlands (dam removal)
- Vegetation clearing, earthmoving, and vehicle use within, or adjacent to, waterways and wetlands
- Unmitigated sediment laden stormwater entering creeks or wetlands as runoff
- Creation of waterway crossings for vehicles
- Obstruction of surface water flows and aquatic fauna passage
- Spills of contaminants such as fuels, oils or chemicals that could migrate into waterways.

8.1.1 Removal and Diversion of Waterways

Within the project area, approximately 36.2 km of mapped streams (watercourses and drainage lines) will be directly impacted by clearing activities and stream diversions. In the Upper Suttor River sub-catchment (southern project area), this includes direct impacts on the following streams mapped by DERM (2012b):

- 6.2 km of 1st order streams
- 9.2 km of 2nd order streams
- 2.2 km of a 3rd order stream.

In the Rosella Creek sub-catchment (northern project area), the following streams mapped by DERM (2012b) will be directly impacted:

- 11.6 km of 1st order streams
- 1.9 km of 2nd order streams
- 5.1 km of 3rd order streams
- 50 m of 4th order streams.

Five stream diversion channels would need to be constructed; four in the Suttor Creek sub-catchment, and one in the Kangaroo Creek sub-catchment (KBR, 2012) (**Figure 4.1**).

Diversion 1 – West Pit 1

The Suttor River north tributary that runs through West Pit 1 will be diverted between West Pit 1 and South Pit 1. Diversion 1 is approximately 3.7 km in length and will divert stormwater runoff in a general east to west direction towards the Suttor River (**Figure 4.1**).

Diversion 2 – South Pit 1

The natural drainage line which intersects South Pit 1 will be diverted and will separate South Pit 1 and South Pit 2. Diversion 2 extends approximately 5.75 km and will convey stormwater runoff in a western direction, to the confluence with a 3rd order tributary of the Suttor River (**Figure 4.1**).

Diversion 3 – South Pit 1

Diversion 3 is located to the west of East Pit 2 and intersects a tributary of the Suttor River to divert stormwater runoff away from South Pit 1. This diversion is approximately 2.6 km in length and will convey flow directly into Diversion 2 (**Figure 4.1**).

Diversion 4 – East Pit 2

Diversion 4 is located to the east of East Pit 2 and conveys stormwater runoff approximately 1.4 km in a northern direction, to a tributary of the Suttor River. Diversion 4 is located upstream of Diversion 3 and Diversion 2, respectively (**Figure 4.1**).

Diversion 5 – North Pit 1

A small drainage diversion is planned to allow water to bypass the North Pit and flow to Kangaroo Creek (**Figure 4.1**). This drainage diversion would remain as a permanent structure to divert water around the North Pit and its final void.

A 1.8 km drainage diversion channel/bund would also be constructed between the North Pit 1 and its spoil area, to convey flows in a south-easterly direction. This drainage diversion channel/bund will drain into a stormwater pond for re-use on site (e.g., dust suppression or process water), or would be discharged into a 1st order tributary of Kangaroo Creek (**Figure 4.1**), if suitable discharge conditions can be met (**Section 8.2.1**).

Diversion channels would be designed to replicate length, flow rate and velocities of the streams that have been removed, in an attempt to minimise changes in hydrology, levee banks will be constructed between creek diversions and the mining areas where required, to maintain separation of clean (natural) waters and mine water during flood events. Diversion channels would be designed in accordance with the DEHP's methodology (e.g., Australian Coal Association Research Program Guidelines [ID&A 2002]), to minimise changes in flow conditions and behaviour.

Where possible, construction of diversion channels and dewatering of impacted waterways would occur during the dry season, when the extent of wetted habitat in the project area is greatly reduced, and when streams are expected to support the lowest diversity and abundance of aquatic species (e.g., fish, turtles, and macroinvertebrates). Any disturbance to breeding places would be undertaken in accordance with an approved SMP, DMP, or other relevant authorisation, to ensure compliance with the NC Act. A General Fisheries Permit under the *Fisheries Act 1994* would be obtained to take, remove, or relocate fish during site establishment.

Macrophyte communities will be impacted during establishment of stream diversion channels. However, macrophytes are expected to rapidly colonise the constructed diversion channels. Therefore, impacts to macrophytes during establishment of stream diversion channels are expected to be minor, and short in duration. Diversion channels will be revegetated according to an approved plan (potentially as part of an Erosion and Sediment Control Plan during mine operations and as part of a Rehabilitation Management Plan in the longer term), which should minimise erosion by stabilising channel banks and beds, thus reducing sediment loads.

Management of diversions will include measures to establish riparian corridors to achieve riparian vegetation continuity along diversion channels. This should allow biogeochemical processes to continue in diversion channels, which would assist in regulating water quality.

It is expected that the diversion channels would be colonised by macroinvertebrate species via mobile adult migration. As a result, the impact on aquatic fauna is unlikely to be significant in the longer term.

The diversion channels would be monitored for physical condition (e.g., bank stability, erosion, and physico-chemical water quality), and biological condition (e.g., vegetation cover, health, and utilisation by aquatic fauna).

8.1.2 Removal of Dams

Two lacustrine water bodies (dams) are likely to be removed as part of the Project. One of the dams is approximately 5 ha in area and is located within the proposed West Pit 1 (**Figure 4.2**). The other dam is approximately 0.8 ha in area and is in the path of the proposed southern-most stream diversion, and thus would need to be modified as part of construction works for this.

The removal of these lacustrine water bodies will potentially have a direct impact on individual fauna, as well as an indirect impact through reduction of potential breeding habitat. Excavation of the larger dam (Site S2) would also remove potential breeding habitat for water birds, and a dry season water source for other terrestrial fauna, including the squatter pigeon (*Geophaps scripta* – race not confirmed), and black-throated finch (*Poephila cincta* – race not confirmed), which were observed around this dam during field surveys (**Section 7.2.3**).

Pursuant to Section 332 of the *Nature Conservation (Wildlife Management) Regulation 2006*, the disturbance of these habitats would be undertaken in accordance with an approved SMP, DMP, or other relevant authorisation, to ensure compliance with the NC Act. This is relevant to freshwater turtles. A General Fisheries Permit under the *Fisheries Act 1994* would also be obtained to take/remove fish during site establishment. These measures would minimise impacts on aquatic fauna.

8.1.3 Indirect Impacts on a wetland of High Ecological Significance

The HES wetland on the western boundary of the project area (**Sections 7.1.2** and **7.2.2**) would remain undeveloped for the duration of the Project. Unmitigated impacts on this wetland may result from:

- Development in the catchment of this wetland resulting in detrimental impacts on the hydrological regime of this wetland
- Mine-affected water or sediment laden run-off from disturbed areas, entering the wetland.

This wetland has a catchment area of 4.2 km^2 (KBR 2012b). During mining, this catchment will be developed, reducing flow to the wetland. The mine will reduce the catchment area by approximately 43%, to 2.4 km^2 (KBR 2012b), for a period of some 16 years. There is likely to be a temporary change in plant species composition as hydrological regimes change over time. However, reinstatement of the current regimes are considered likely to see the return of the wetland to its current state over time. The plant species present within the wetland suggest a semi-permanent nature and as such,

the ecosystem would be adapted to periods of wetting and drying and corresponding changes in dominant species, particularly in the ground layer. A decrease in the size of the catchment (and therefore inflows) is likely to increase the proportion of the wetland dominated by terrestrial species over time. Provided that a core area of wetland remains seasonally inundated, a representative suite of plants should persist and enable recolonisation over time as the wetland expands in area.

During the period of time where the effective catchment size is reduced, the impact of feral pigs may be more concentrated on a smaller area of wetland as inflows decrease over time. A culling program should be considered to minimise damage to the wetland areas which are intended to be a seed source for the broader wetland upon its reinstatement.

Post closure, the remediation strategy for the area will include returning the land to a similar hydrological profile, creating a similar catchment for the wetland (KBR 2012b).

A suitable baseline assessment and ongoing monitoring will be undertaken to monitor the status of the wetland, including seasonal variation. These monitoring requirements would be included in the REMP.

Sediment and erosion control structures will be installed upslope of this wetland prior to the commencement of works to negate sediment laden runoff entering this wetland. These sediment and erosion control structures will be monitored and maintained throughout the site establishment works.

8.1.4 Vegetation Clearing, Earthmoving, and Control of Stormwater Runoff

The establishment of project infrastructure would potentially impact surface water quality through increased erosion of sediments that are exposed after vegetation clearing. If not appropriately control, erosion of sediments can lead to increased suspended sediment loads to waterways, which can reduce light penetration and visibility, limiting plant growth, and impeding fish movement. Increased sedimentation can also reduce waterway depths, change drainage patterns, and smother benthic flora and fauna.

The mobilisation and deposition of fine sediments also has the potential to fill downstream pools. This is unlikely to impact significantly on retained minor (first order) tributaries of the project area as these watercourses are expected to only carry runoff for short periods, following intense or sustained rainfall events, and are not expected to provide wetted habitat for extended periods. Sediment deposition in larger watercourses (second order and higher) can reduce habitat diversity, and the number of pools available as refuge habitat in drier times. Although sedimentation (predominately sand) has already limited substrate complexity and associated habitat diversity in the waterways draining the project area (in particular the Suttor River and its tributaries), accelerated sedimentation from project activities could result in a decline in the abundance and diversity of both invertebrate and fish communities in downstream receiving environs.

Aquatic ecosystems within the project area also have the potential to be impacted by nutrients, salts, metals, or other contaminants that are adsorbed onto sediments washed into the waterways. Increased nutrient loads can promote excessive growth of aquatic flora (algae and macrophytes), provided environmental conditions also favour photosynthesis (i.e., light availability). Excessive growth of aquatic flora can reduce oxygen concentrations, which, if severe enough, can lead to mortality of oxygen dependent fauna (e.g., fish, macroinvertebrates). Excessive growth of surface aquatic flora can block sunlight for submerged flora, limiting their photosynthetic activity.

Impacts from potential increased nutrient loads to waterways are, however, expected to be minimal, providing that adequate sediment and erosion controls are established prior to site clearing, and are maintained throughout the site establishment works.

Hydrocarbon based leaks or spills from construction equipment represents a potential risk, as most are toxic to aquatic flora and fauna at relatively low concentrations. Runoff of spilt fuels and oils into waterways is only likely to occur if spills occur in close proximity to waterways (natural stormwater channels and constructed diversion channels), or if the spill or leak is left uncontrolled. A fuel or oil spill in excess of ten litres that ends up in a waterway is likely to have more immediate impacts on aquatic flora and fauna. The severity and duration of impacts will be directly related to the quantity of fuel or oil spilt, and the effectiveness of containment measures.

The risk of impacts to aquatic flora and fauna from a fuel or oil spill is lower during the dry season (when watercourses are dry) as spills are likely to be contained before they disperse throughout the waterway.

The following measures would assist in minimising the impacts of sediment and contaminant runoff on aquatic habitats, flora, and fauna:

- Where possible, infrastructure should be located away from the riparian zone of streams. Suggested buffers from streams, measured from the top of the highest bank and on both sides of the stream, are as follows:
  - 10 m for a 1st order stream and where there is a defined channel where water flows intermittently
  - 20 m for a 2nd order stream and where there is a defined channel where water flows intermittently or permanently
  - 40 m for any 3rd order or greater stream, where there is a defined channel and where water flows intermittently or permanently
- An Erosion and Sediment Control Plan will be developed for the Project, and implemented during site establishment to minimise the likelihood of project-related activities increasing turbidity and sedimentation. The key features of this plan will involve:
  - Concentrating work to as small as area as practicable to limit the amount of disturbed area exposed at any one time
  - Minimising the number of passes by heavy earthmoving equipment when undertaking soil stripping activities
  - Implementing sediment limitation devices (e.g. settlement/evaporation dams, drainage ditches) to restrict sediment movement off-site
  - Constructing bunds to restrict flow velocities across the Project area and therefore reducing scour of stream bed and banks
  - Limiting vegetation clearing work during heavy rainfall
  - Adopting stormwater controls and upstream treatment, such as infiltration devices and vegetation filters
  - Revegetating and/or use of other stabilisation techniques, considering seasonal influences, upon completion of works
  - Minimising vegetation disturbance, especially riparian vegetation

  - Implementing dust suppression measures including irrigation, energy dissipation and scour protection measures such as matting, riprap and gabions (KBR 2012b).

- Clearly defined access and work use areas for plant and equipment should be established, and all members of the construction crew should be aware of these access and work area limits. Movement of plant and equipment should be restricted to these areas so as to minimise the potential for uncontrolled spills or leaks entering the stream
- Areas for vehicle and machinery maintenance, refuelling, and storage of fuels, lubricants, and batteries, should be bunded in accordance with AS 1940
- Maintenance of plant and equipment to minimise the risk of leaks and spills of oils and fuels, and ensuring that refuelling does not occur outside the designated bunded area (refuelling area)
- Ensuring emergency spill kits are available and readily accessible for all plant and equipment at all times. The kits should include equipment for containment and clean-up of spills on dry soils/sediments, and to water (e.g., floating booms).
- All spills of contaminants (including diesel, hydraulic fluid, oil etc.) should be contained (where safe to do so), and immediately reported to the Project's Environmental Officer.

8.1.5 Vehicle Stream Crossings and Obstruction of Fauna Passage

The Project requires approximately 16 vehicle stream crossings (**Figure 4.1** and **Figure 4.2**), including:

- Six crossings of 1st order streams
- Two crossings of 2nd order streams
- Three crossings of 3rd order streams
- One crossing of a 4th order stream (Kangaroo Creek)
- Four crossings of stream diversions.

Construction of stream crossings can cause both direct and indirect impacts. Direct impacts include a loss of riparian and aquatic habitat due to disturbance of the bed and banks, increased sunlight exposure, and accelerated sedimentation. Indirect impacts include long-term barriers to fish movement, alteration of habitats, and increased pollution.

Many of the fish native to ephemeral or intermittent waterways migrate up and downstream and between different habitats at particular stages of their lifecycle. Bridge crossings of permanent or semi-permanent streams generally pose little problem to these migrating fish if the morphology of the stream-bed and water flow patterns remain largely unaltered. However, causeway and culvert crossings can create major discontinuities in the water flow pattern and bed morphology of a stream, or if there is a tunnel effect created (NSW Fisheries, 1999). Fish may be physically unable, or unwilling, to negotiate such discontinuities. It is therefore important not to create a barrier or obstacle within the stream.

Stream crossings should be designed in a way that maintains or enhances water flows, water quality, stream ecology and existing riparian vegetation. Impacts to the hydrologic, hydraulic, and geomorphic functions of the stream should be minimised.

Stream crossings should be designed in accordance with Queensland Fisheries guidelines for design of stream crossings (FHG 001; Cotterell 1998) and the NSW Office of Water (2010) guidelines for watercourse crossings, which includes:

- Minimising construction footprint and extent of proposed disturbances within the watercourse and riparian corridor
- Where possible, avoid structured native riparian vegetation
- Maintaining existing or natural hydrologic, hydraulic, geomorphic, and ecological functions of the watercourse
- Ensuring that where a raised structure or increase in the height of the stream bed is proposed, there will be no detrimental impacts on the natural hydrologic, hydraulic, geomorphic, and ecological functions
- Maintaining natural geomorphic processes by:
  - Accommodating natural watercourse functions
  - Avoiding alterations to natural bank, full, or floodplain flows, or increased water levels upstream
  - Avoiding changes to the gradient of the stream bed, except where necessary to address existing bed and bank degradation
  - Avoiding increases in flow velocities by, for example, constricting flows
- Protecting against scour by:
  - Providing any necessary scour protection, such as rock rip-rap and vegetation
  - Ensuring scour protection of the bed and banks downstream of the structure is extended for a distance of either twice the channel width, or 20 m whichever is the lesser
- Stabilising and rehabilitating all disturbed areas including topsoiling, revegetation, mulching, weed control, and maintenance, in order to adequately restore the integrity of the riparian corridor
- Where causeways or bed level crossings are proposed:
  - The deck of the crossing should be at the natural bed elevation
  - The crossing should have a vertical cut-off wall on the downstream side of the crossing to a minimum depth of 1 m and minimum width of 100 mm (**Figure 8.1**)
- Approaches to crossings should be sealed and incorporate roadside drainage, such as stabilised table drains where necessary
- Where culverts are proposed on small order streams:
  - Box culverts are preferred to pipes
  - Culverts should be aligned with downstream channels
  - Elevated dry cells and recessed wet cells should be incorporated with the invert at or below the stable bed level (**Figure 8.2**)
- The culvert design should be certified by a suitably qualified engineer
- The design should ensure wet cells have a minimum water depth of 0.2–0.5 m to encourage fish passage

- The design should minimise changes to the channels natural flow, width, roughness and base-flow water depth.

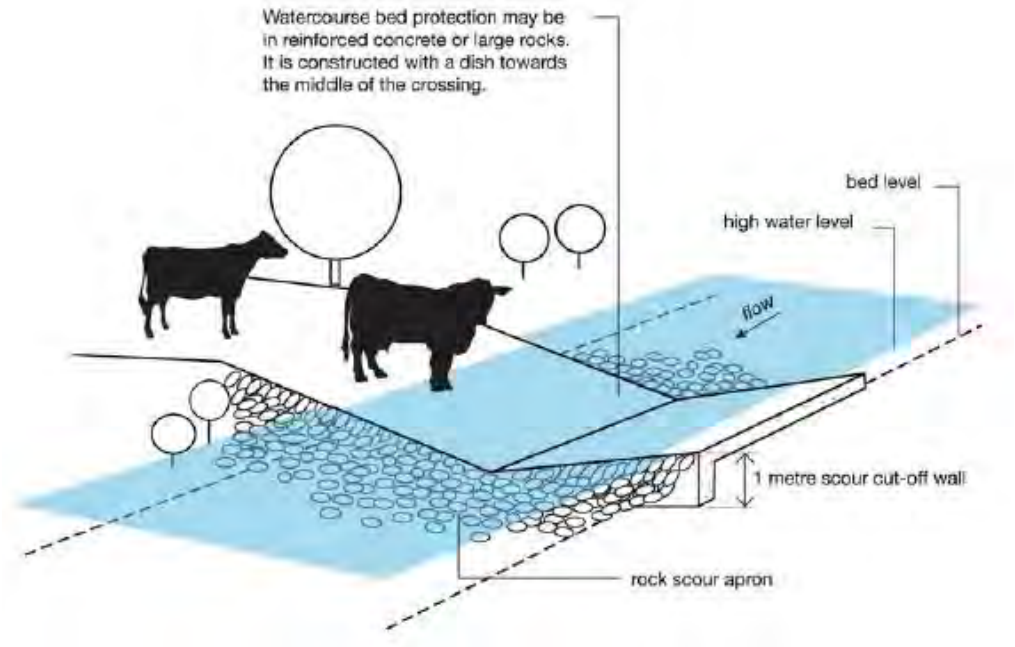

Figure 8.1 Typical splash crossing for vehicles (and livestock) on small intermittent watercourses (NSW Office of Water, 2010)

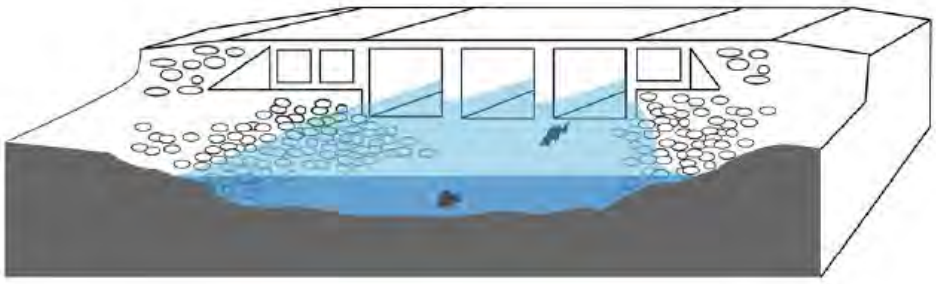

Figure 8.2 Conceptual road crossing allowing fish passage (NSW Office or Water, 2011)

8.2 OPERATIONS PHASE

Without appropriate mitigation measures in place the mine operation has potential to impact on aquatic ecological values in the project area and broader catchment through:

- Discharge of excess pit water and discharge or seepage of other mine affected water into waterways
- Uncontrolled stormwater runoff from disturbed areas entering waterways or wetlands, affecting water and sediment quality
- Uncontrolled dust emissions and deposition into waterways or catchment areas
- Altering the geomorphology and ecology of a waterway through changes in flow and water quality.

8.2.1 Mine-affected Water

Water within the Project area would be segregated, based on quality, into:

- Mine-affected water (MAW), from disturbed catchments and groundwater inflows into the pits
- Sediment-affect water, from disturbed catchments, suitable for discharge after sediment removal in accordance with the Byerwen Coal Project Mine Water Management Plan (KBR 2012b).
- Clean water, from undisturbed catchments, suitable for direct discharge in accordance with the Byerwen Coal Project Mine Water Management Plan (KBR 2012b).

MAW may not be suitable for direct release, due primarily to elevated salt and alkalinity (KBR 2012b). This water may be generated from:

- Groundwater ingress to open cut pits
- Pit wall runoff
- Runoff from fresh waste rock spoil dumping faces, prior to rehabilitation.

MAW would be collected in sumps and pumped to dams at the surface where it would be contained on site in dams for periods of time until there is sufficient dilution to allow release to the environment and still achieve water quality objectives. This may be achieved either through dilution in the receiving environment, blending water within the mining area or a combination of these strategies (KBR 2012b).

MAW will only be discharged from the dams if it meets the discharge criteria. The discharge criteria will be developed for the controlled release of excess MAW to a standard and in a manner that minimises impacts on the health and integrity of receiving environments. KBR (2012b) have developed release rules for MAW. Release rules have been developed with the objective of ensuring releases do not result in unacceptable water quality in the receiving environment. The discharge criteria for MAW will be included in the Environmental Authority (EA). Several factors are considered in order to ensure this objective is met:

- Receiving environment flow
- Receiving environment water quality
- Mine release rate
- Mine release water quality

The release rules stipulate the MAW water quality to be released and set flow triggers (discharges are only permitted when there is a specified flow in the receiving environment) for each receiving waterway. Scour protection will be provided at discharge points, where required.

The mine water system will be operated such that the water quality objectives in the receiving environment will be maintained. Water quality objectives have been derived to protect the environmental values in these waterways and have been developed based on a baseline monitoring program (refer to Surface Water Quality, KBR 2012a for further details).

KBR (2012b) note that, whilst a range of parameters will be monitored, the critical water quality indicator that is likely to constrain releases to the environment is salinity (measured as electrical conductivity). The electrical conductivity trigger values within the Mine Water Management Plan are based on the 80th percentile electrical conductivity values observed in the baseline monitoring program

The Queensland Water Quality Guidelines (2009) (Appendix D – Compliance Assessment Protocols) are built around the premise that aquatic ecosystems can tolerate (without significant impact) variation in physico-chemical stressors up to the 80th percentile of the same indicator when assessed against a suitable reference site.

KBR (2012b) discuss impacts on water quality in the Suttor River and tributaries and note that, by virtue of the release conditions, there is no change to the 80th percentile EC in the Suttor River since no releases would be permitted from the mine when the EC in the Suttor River upstream of the mine is 2,040 µS/cm or above. There is a very slight increase in the modelled EC at percentiles below the 80th percentile, reflecting the effect of the releases. However these are of a very low order (10 µS/cm) and would not have measurable impact on the river water quality.

Given that site releases will be strictly regulated and there is no significant change expected to key physico-chemical attributes in the receiving environment, adverse impacts on aquatic ecosystems are not expected.

8.2.2 Control of Run-off

Runoff from catchment areas within the project area that are undisturbed by mining activities will be isolated and diverted around disturbed areas to minimise mixing of clean and dirty runoff. This will reduce the volume of water requiring management on-site.

Clean Water

Runoff from undisturbed catchments upstream of the mining area would be diverted around the disturbed area and released directly to the environment. In some cases a clean water dam is proposed either to facilitate the diversion, or to provide a source of clean water that can be used to blend with MAW (if required) to facilitate release (KBR 2012b).

Sediment-affected Water

Areas that drain disturbed areas such as the MIA, coal stockpiles, recently rehabilitated waste rock dumps, access roads and laydown areas have the potential to generate sediment laden runoff. Sediment-affected water would pass through sedimentation dams prior to release to the environment in accordance with a Water Management Plan to be prepared for the Project (KBR 2012b).

On the basis of the soil and waste rock characteristics, the waste rock may be dispersive (KBR 2012b). Sedimentation basins will therefore be utilised until disturbed areas are sufficiently rehabilitated and stabilised.

8.2.3 Stream Hydrology and Geomorphology

The geomorphology and ecology of natural streams within the Project area may be altered by changes in flow and water quality.

The Project has the potential to alter the hydrology of surface water systems by capturing water in dams, loosing water in the form of dust suppression or pond evaporation, and releasing water during flow events.

The Byerwen Coal Project Mine Water Management Plan (KBR 2012b) determined that the mine water system is not expected to have any significant impacts on the hydrological regime in the Suttor River or Kangaroo Creek. The palustrine wetland (a HES wetland) and its catchment would be temporarily affected during mining. Post closure, the remediation strategy for the area will including returning the land to a similar hydrological profile, creating a similar catchment for the wetland (KBR 2012b). Following remediation it is considered likely that the wetland would be restored towards its current condition.

8.2.4 Noise and Vibration – Construction, Operation and Decommissioning Phases

The introduction of significant levels of noise and vibration into the environment under favourable propagation conditions is recognised as a form of habitat disturbance. Follow on (secondary) impacts resulting from this type of habitat disturbance could potentially include behavioural modification to native fauna.

Key project activities which have the potential to propagate noise and vibration include:

- Movement of vehicles and plant (all project phases)
- Installation of infrastructure (construction phases)
- Drilling, blasting and excavation (operation phases)

Analogous data and studies on the specific potential impacts on inland aquatic fauna are limited, with studies focussed more on marine environments. However, under specific conditions potential impacts to fish species as a result of anthropogenic increases in highly percussive noise sources (e.g. pile driving adjacent water bodies) may include disruption or alteration of fish behaviour, hearing, physiology and even injury or mortality in severe cases (Popper & Hastings, 2009).

It should be clearly noted that the existing conditions across the project area are unlikely to present noise and vibration propagation scenarios sufficient to cause any of these noted potential impacts. This is especially the case given the highly ephemeral nature of aquatic habitat within proximity to the project area, which provides a natural mitigation measure. As surface water does not persist for the majority of the hydrological cycle, such potential impacts could only occur to a small portion of aquatic habitat for a small portion of the time. Further reducing the scale of potential impact is the fact that habitat disturbance caused by noise and vibration is expected to be highly localised in the immediate vicinity of project activities.

Overall, potential impacts associated with noise and vibrations are expected to be non-significant.

8.3 DECOMMISSIONING PHASE

The areas disturbed by mining will be rehabilitated as per a Rehabilitation Management Plan. Spoil will be graded and a shedding-type cover provided to direct water away from the spoil and minimise infiltration (KBR 2012c).

The Project will create four voids that will likely remain as permanent depressions in the landscape and act as groundwater sinks following the cessation of mining. Water inflows

from groundwater, surface water runoff and direct rainfall will result in the formation of pit lakes within these voids. These pit lakes will increase in depth and area slowly, over several hundred years, until a steady state condition is reached where water losses (evaporation) are equivalent to water inputs. Importantly, under no conditions will water from within the void rise to final void rim (KBR 2012c). Therefore, discharges to the surface water system are not expected to occur.

The salinity of near surface water is expected to be much lower than at depth, with high dissolved oxygen, neutral to slightly alkaline, with low to very low dissolved metal concentrations. These conditions are expected to support an aquatic ecosystem that can function independently of the poorer quality water below the pycnocline (the layer separating water of two different densities (KBR 2012c).

9. CUMULATIVE IMPACTS AND MITIGATION MEASURES

Byerwen Coal has identified 56 projects which have the potential to contribute to cumulative environmental and social impacts, including:

- Projects in the Bowen Basin, or within 150 km of the Project
- Projects in the Isaac Regional Council, Whitsunday Regional Council, or Mackay Regional Council
- Projects for which an EIS process has commenced under the EP Act or *State Development and Public Works Organisation Act 1971* (SDPWO Act)
- Other projects of which Byerwen Coal is aware, including projects for which QCoal is a proponent or which are identified on government maps or websites
- Known major infrastructure projects (e.g., power stations or water infrastructure) that are seeking approval or have obtained development approval other than through an EIS.

Cumulative impacts can occur over both spatial and temporal scales. They are synergistic, where interactions, combinations and new patterns of connection are important considerations (Vlachos 1985; as cited in Elliott and Thomas 2009). **Table 9.1** considers the different sources of cumulative environmental impacts and how they may relate to aquatic ecosystems impacted by the Project (Canter and Kamath 1995; Sadar 1994; as cited in Elliott and Thomas 2009).

Table 9.1 Sources of Cumulative Environmental Impact Relating to Aquatic Ecosystems

Issue Type*	Main Characteristics*	Potential Impacts on Aquatic Ecosystems	Mitigation Measures to avoid Project Contributing to Cumulative Impacts
Time Crowding	Frequent and repetitive impacts on a single environmental medium	• Wastes sequentially discharged into waterways, wetlands or catchments.	• Proper management of fuels, oils and hazardous substances. • Runoff control – implementation of location -specific sediment and erosion control plans. • Discharge criteria to meet EA conditions.
Space Crowding	High density of impacts on a single environmental medium	• Habitat fragmentation in waterways. • Removal of lacustrine wetland habitat. • Removal of gilgai wetland habitat.	• Aquatic and riparian habitat reinstated in diversion channels. • Alternative lacustrine wetland habitat created, resulting in an overall increase in lacustrine wetland area. • Discharge criteria to meet EA conditions.

Issue Type*	Main Characteristics*	Potential Impacts on Aquatic Ecosystems	Mitigation Measures to avoid Project Contributing to Cumulative Impacts
Compounding Effects	Synergistic effects due to multiple sources on a single environmental medium	• Downstream effects of several projects in the Suttor and Belyando sub-catchments and broader Burdekin catchment, including impacts on the Great Barrier Reef.	• Management of fuels, oils and hazardous substances. • Runoff control – implementation of location-specific sediment and erosion control plans. • Discharge criteria to meet EA conditions.
Time Lags	Long delays in experiencing impacts	• Accumulation of contaminants in sediments. • Bioaccumulation of contaminants in aquatic flora, fauna or terrestrial predators.	• Management of fuels, oils and hazardous substances. • Mitigation measures for dusts and other gaseous emissions • Runoff control - implementation of location-specific sediment and erosion control plans. • Discharge criteria to meet EA conditions.
Space Lags	Impacts resulting some distance from their sources (e.g., gaseous emissions into the atmosphere)	• Alteration of water and sediment chemistry in the broader catchment or neighbouring catchments.	• Implement mitigation measures for dusts and other gaseous emissions.
Triggers and Thresholds	Impacts to biological systems that fundamentally change system behaviour (e.g., effects in changes in forest age on forest fauna)	• Altered runoff volumes, velocities and patterns (flow regimes) impacting fish movement and spawning cues in aquatic fauna. • Flow alteration resulting in scouring and habitat loss for aquatic flora and fauna.	• Diversion channels designed to mimic: gradient, meander, substrate composition, in-stream habitat and vegetation of natural waterways. • Discharge to waterways to follow EA conditions, including meeting appropriate discharge quality and only discharging when high flow is encountered in receiving waters.

Note *: After Sadar (1994) as cited by Elliot and Thomas (2009).

In order for impacts to be considered cumulative, they must:

- Not occur in isolation (i.e., not be an impact unique to one project only)
- Occur within relevant spatial and temporal scales.

Based on a consideration of impacts likely to result from the Project, and sources of cumulative environmental change identified by Elliot and Thomas (2009) (**Table 9.1**), it is considered that the Project is unlikely to contribute to significant cumulative impacts on aquatic ecological values in neither a spatial nor temporal context.

10. CONCLUSION

The aquatic ecological information compiled for this study is considered adequate to describe the late wet ecological condition of riverine systems, lacustrine wetlands, and a palustrine wetland, within the project area for Byerwen Coal. Knowledge of the ecological condition of these water bodies allows an assessment to be made of the likely impacts of the proposed mine on aquatic ecology and biodiversity.

The desktop assessment and 'late wet' season field surveys detailed in this report provide sufficient information to assess the likely impacts of the Project on aquatic ecology and biodiversity. A further 'early wet' season survey was completed in December 2012, for which results are not currently available.

Existing aquatic ecological conditions in the project area, as interpreted from published and collected data, suggest that the waterways transecting the project area incur flow intermittently, and are likely characterised by high inter-annual flow variability. Wetlands within the project area, particularly lacustrine wetlands, provide semi-permanent water. The wetlands, waterways, and associated riparian corridors of the project area provide both aquatic and terrestrial fauna species with opportunities for refuge, foraging and also potential nesting and breeding habitat.

The Project will have both direct and indirect impacts on the aquatic values of Kangaroo Creek and its tributaries, and both direct and indirect impacts on tributaries of the Suttor River. Direct impacts are focussed on the removal of approximately 36.2 km of riverine habitat, including approximately 18.6 km of riverine habitat in the Kangaroo Creek catchment and 17.6 km of riverine habitat in the Suttor River catchment. These impacts are deemed to be short and medium term only, generally confined to the life of the Project.

No aquatic 'Threatened Ecological Communities' have been detected in the project area, nor are any expected to occur.

The Project is unlikely to impact on any wetlands of international significance (Ramsar wetlands) or wetlands of national importance. A HES wetland, in this case a palustrine wetland, is located on the western boundary of the project area and will remain undeveloped for the life of the mine.

The Project will remove two mapped lacustrine wetlands (dams), comprising approximately 5.8 ha of low to medium value aquatic habitat and some low to medium value gilgai wetland. These impacts would be permanent.

No EVNT aquatic flora species are likely to occur within the project area. The HES wetland contains a number of 'Priority' flora species. Both direct and indirect impacts on this wetland, including significant changes to the hydrological regime, should be avoided.

Macroinvertebrate and fish sampling was undertaken in representative habitats where adequate water was encountered.

Macroinvertebrate communities sampled in the late wet season of 2012 were largely dominated by pollution and disturbance tolerant taxa. Overall AUSRIVAS O/E50 scores indicate that most sites surveyed were significantly impaired, with one site being severely impaired. Comparison of macroinvertebrate taxonomic richness and biotic sensitivity indices (SIGNAL 2), suggest that most aquatic survey sites had been under long-term stress from decreasing water quality (possibly natural or from past and present land

uses), harsh physical conditions (intense seasonal runoff and erosion and deposition of fine sediments), or other anthropogenic effects.

Fish surveys identified eight species of fish, all of which were native. No EVNT or Special Least Concern (platypus) aquatic fauna species, were recorded, or are likely to occur within the project site. A number of Priority fish species are either known, or may occur within the waterways transecting the project site. However, both direct and indirect impacts on these species through habitat modification are deemed to be short term and confined to the establishment phase of the Project. Direct impacts can be reduced by relocating fish in accordance with a General Fisheries Permit where de-watering of water bodies is undertaken.

Freshwater turtles are likely to occur within lacustrine wetlands and semi-permanent pools on watercourses. Turtles would need to be relocated from dewatered areas in accordance with a Species Management Program or Damage Mitigation Permit.

Cumulative impacts within the broader Burdekin River catchment are expected to be minimal.

With the implementation of measures provided in **Section 8** of this report, the Project is unlikely to result in a significant impact on threatened or Priority aquatic species, aquatic ecological communities or their habitats. The ecological integrity of the Suttor River, Kangaroo Creek or their downstream receiving environs is unlikely to be significantly impacted by the Project.

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ATTACHMENT A – SITE PROFILES

Location:	Suttor River	Site Code:	S1	Date:	01/05/2012	Latitude:	-21.2883	Longitude:	147.8187 GDA 1994

Upstream	Left Bank	Downstream	Right Bank
			

Watercourse Description	
Wetland type	Riverine
Topography	Open depression
Seasonality	Ephemeral
Flow level	Low-moderate
Mean wetted width (m)	10
Bed slope (˚)	1
Bank slope (L/R) (˚)	6/6
Riparian zone width (L/R) (m)	50/50
Water Quality	**Observed**
Colour	Opaque
Water surface	Normal
Water odour	None
Temperature (˚C)	21.6
pH	6.8
Electrical conductivity (µS/cm)	174
Dissolved oxygen (mg/L)	6.53
Dissolved oxygen (% saturation)	79.3
Turbidity (NTU)	Equipment failure
Alkalinity (mgCaCO3/L) (lab.)	38

Macroinvertebrates	Edge	Bed
Mean sample depth (m)	0.1	0.15
Sample count	70	32
No. of taxa	20	9
SIGNAL 2 score	4.05	4.10
AUSRIVAS O/E50 score	0.89	0.52
AUSRIVAS band	A	B
EPT %	25	33

Habitat Description	Edge	Bed
Substrate (%)		
Bedrock	0	0
Boulders (>256 mm)	0	0
Cobbles (64–256 mm)	0	0
Pebbles (4–64 mm)	0	0
Gravel (2–4 mm)	50	50
Sand (0.05–2 mm)	50	50
Silt/clay (<0.05 mm)	0	0
Snags and Large Woody Debris[#]		
Detritus (leaves, twigs)	S	L
Sticks (<2 cm Ø)	S	L
Branches (<15 cm Ø)	L	L
Logs (>15 cm Ø)	L	L
Other Attributes[#]		
Periphyton	N	N
Moss	N	N
Filamentous algae	N	N
Macrophytes	N	N
Bank overhang vegetation	L	N
Blanketing silt	N	N
Substrate anoxia	N	N
Canopy Cover (%)	30	30
Shading (%)	40	40

Flora and Vertebrate Fauna captured/observed		
Fauna		
Fish	***Common Name***	***Method****
Leiopotherapon unicolor	Spangled perch	S, F
Melanotaenia splendida	Eastern rainbowfish	S, F, M?
Amniataba percoides	Barred grunter	S, F, B, M
Mogurnda adspersa	Purple-spotted gudgeon	S, F, M
Ambassis agassizii	Agassiz's glassfish	S, F
Porochilus rendahli	Rendahl's catfish	F
Flora		
Riparian Trees	**Common Name**	**Abundance**
Eucalyptus tereticornis	Queensland blue gum	S
Corymbia tessellaris	Moreton Bay ash	L
Melaleuca bracteata	Black tea-tree	L
Shrubs/Rushes		
Lomandra longifolia	Spiny-headed matrush	M

Notes

* E = Backpack electrofisher (LR-24); F = Fyke net; B = Bait trap; O = Observation; M = Macroinvertebrate net (by-catch).
[#] N = None; L = 1–10 % (little); S = 10–50 % (some); M = 50–75 % (moderate); E = >75 % (extensive).
^ Introduced species.

Location:	Lacustrine wetland	Site Code:	S2	Date:	02/05/2012	Latitude:	-21.2829	Longitude:	147.8406 GDA 1994

Overview (looking upstream)

Edge of Dam

Watercourse Description		Habitat Description	Edge	Bed	Flora and Vertebrate Fauna captured/observed		
Wetland type	**Lacustrine wetland**	**Substrate (%)**			**Fauna**		
Topography	Open depression	Bedrock	0	0	***Fish***	***Common Name***	***Method****
Seasonality	Permanent (dam)	Boulders (>256 mm)	0	0	*Hypseleotris* sp. 1	Midgley's carp gudgeon	F
Water level	High	Cobbles (64–256 mm)	0	0	*Porochilus rendahli*	Rendahl's catfish	F, E
Mean wetted width (m)	120	Pebbles (4–64 mm)	0	0	*Ambassis agassizii*	Agassiz's glassfish	F
Bed slope (˚)	1	Gravel (2–4 mm)	0	0	**Flora**		
Bank slope (L/R) (˚)	1	Sand (0.05–2 mm)	0	0	***Trees***	***Common Name***	***Abundance****
Riparian zone width (L/R) (m)	0/0	Silt/clay (<0.05 mm)	100	100	*Acacia harpophylla*	Brigalow	M
Water Quality	**Observed**	**Snags and Large Woody Debris**			***Macrophytes***	***Common Name***	***Abundance****
Colour	Tannin	Detritus (leaves, twigs)	S	L	*Persicaria* sp.	Slender knotweed	L
Water surface	Normal	Sticks (<2 cm Ø)	L	N	**Notes**		
Water odour	None	Branches (<15 cm Ø)	N	N	Recently augmented dam. Brigalow *(Acacia harpophylla)* previously fringing vegetation, now inundated.		
Temperature (˚C)	24.3	Logs (>15 cm Ø)	N	N	* E = Backpack electrofisher (LR-24); F = Fyke net; B = Bait trap; O = Observation; M = Macroinvertebrate net (by-catch).		
pH	7.1	**Other Attributes**			# N = None; L = 1–10 % (little); S = 10–50 % (some); M = 50–75 % (moderate); E = >75 % (extensive).		
Electrical conductivity (µS/cm)	200	Periphyton	L	L	^ Introduced species.		
Dissolved oxygen (mg/L)	3.07	Moss	N	N			
Dissolved oxygen (% saturation)	40	Filamentous algae	L	N			
Turbidity (NTU)	30	Macrophytes	L	N			
Alkalinity (mgCaCO3/L) (lab.)	88	Bank overhang vegetation	N	N			
Macroinvertebrates	**Edge** / **Bed**	Blanketing silt	N	N			
Mean sample depth (m)	0.15 / 0.8	Substrate anoxia	N	N			
Sample count	278 / 173	Canopy Cover (%)	10	10			
No. of taxa	21 / 11	Shading (%)	15	15			
SIGNAL 2 score	3.11 / 3.67						
AUSRIVAS O/E50 score	NA / NA						
AUSRIVAS band	NA / NA						
EPT %	9 / 18						

Location:	Tributary of Suttor River	Site Code:	S4	Date:	03/05/2012	Latitude:	-21.3215	Longitude:	147.8333 GDA 1994

Upstream

Left Bank

Downstream

Right Bank

Watercourse Description	
Wetland type	**Riverine**
Topography	Open depress.
Seasonality	Ephemeral
Flow level	Moderate
Mean wetted width (m)	3
Bed slope (˚)	1
Bank slope (L/R) (˚)	28/28
Riparian zone width (L/R) (m)	10/10

Water Quality	Observed
Colour	Opaque
Water surface	Normal
Water odour	None
Temperature (˚C)	18.7
pH	7.0
Electrical conductivity (µS/cm)	98
Dissolved oxygen (mg/L)	3.7
Dissolved oxygen (% saturation)	39
Turbidity (NTU)	NR
Alkalinity (mgCaCO3/L) (lab.)	60

Macroinvertebrates	Edge	Bed
Mean sample depth (m)	0.2	0.7
Sample count	80	37
No. of taxa	15	10
SIGNAL 2 score	3.38	3.30
AUSRIVAS O/E50 score	0.62	0.69
AUSRIVAS band	B	B
EPT %	13	20

Habitat Description	Edge	Bed
Substrate (%)		
Bedrock	0	0
Boulders (>256 mm)	0	0
Cobbles (64–256 mm)	0	0
Pebbles (4–64 mm)	0	0
Gravel (2–4 mm)	0	0
Sand (0.05–2 mm)	30	40
Silt/clay (<0.05 mm)	70	60
Snags and Large Woody Webris[#]		
Detritus (leaves, twigs)	L	L
Sticks (<2 cm Ø)	L	L
Branches (<15 cm Ø)	L	L
Logs (>15 cm Ø)	L	L
Other Attributes[#]		
Periphyton	N	N
Moss	N	N
Filamentous algae	N	N
Macrophytes	L	N
Bank overhang veg.	L	N
Blanketing silt	N	L
Substrate anoxia	N	N
Canopy Cover (%)	25	25
Shading (%)	35	35

Flora and Vertebrate Fauna captured/observed

Fauna

Fish	*Common Name*	*Method**
Leiopotherapon unicolor	Spangled perch	F, S
Mogurnda adspersa	Purple-spotted gudgeon	F, S
Ambassis agassizii	Agassiz's glassfish	F, S
Melanotaenia splendida	Eastern rainbowfish	F, S
Amniataba percoides	Barred grunter	F, S

Flora

Riparian trees	*Common Name*	*Abundance[#]*
Acacia harpophylla	Brigalow	M
Terminalia oblongata subsp. *volucris*	Rosewood	S
Eucalyptus tereticornis	Queensland blue gum	S

Macrophytes	*Common Name*	*Abundance[#]*
Cyperus sp.	Sedge	L

Notes

* E = Backpack electrofisher (LR-24); F = Fyke net; B = Bait trap; O = Observation; M = Macroinvertebrate net (by-catch).

[#] N = None; L = 1–10 % (little); S = 10–50 % (some); M = 50–75 % (moderate); E = >75 % (extensive).

^ Introduced species.

Location:	Gilgai	Site Code:	S5	Date:	04/05/2012	Latitude:	-21.2781	Longitude:	147.8559 GDA '94

Overview

Overview

Watercourse Description	
Wetland type	Gilgai
Topography	Flat
Seasonality	Semi-permanent
Mean wetted width (m)	15
Mean depth (m)	0.7
Water Quality	**Observed**
Colour	Clear
Water surface	Normal
Water odour	None
Fauna (observed)	
Vertebrates	***Common Name***
Limnodynastes tasmaniensis	Spotted marsh frog
Litoria nasuta	Rocket frog
Invertebrates	***Common Name***
Austrothelphusa transversa	Freshwater crab
Branchinella sp.	Fairy shrimp

Notes

Pig tracks around gilgai.

[#] N = None; L = 1–10 % (little); S = 10–50 % (some); M = 50–75 % (moderate); E = >75 % (extensive).

^ Introduced species.

Flora

Trees	***Common Name***	***Abundance[#]***
Acacia harpophylla	Brigalow	E
Shrubs	***Common Name***	***Abundance[#]***
Sesbania canabinna	Sesbania pea	S
Parthenium hysterophorus	Parthenium	S
Harrisia sp.	Harissia cactus	L
Enchylaena tomentosa	Ruby saltbush	L
Scleolaena muricata	Black roly-poly	L
Macrophytes	***Common Name***	***Abundance[#]***
Juncus sp.	Common rush	S
Marsilea mutica	Nardoo	S
Typha domingensis	Cumbungi	S
Monochoria cyanea	Monochoria	L
Cyperus sp.	Sedge	L
Persicaria attenuata	Smartweed	L
Grasses	***Common Name***	***Abundance[#]***
Poa sp.	Tussock	E
Echinochloa colona^	Awnless barnyard grass	S

Location:	Tributary of Suttor River	**Site Code:**	S6	**Date:**	04/05/2012	**Latitude:**	-21.3061	**Longitude:**	147.8849 GDA'94

Upstream	**Left Bank**	**Downstream**	**Right Bank**
			

Watercourse Description		**Habitat Description**	**Edge**	**Bed**
Wetland type	Riverine	**Substrate (%)**		
Topography	Open depres.	Bedrock	0	0
Seasonality	Ephemeral	Boulders (>256 mm)	0	0
Flow level	Low	Cobbles (64–256 mm)	2	2
Mean wetted width (m)	1	Pebbles (4–64 mm)	18	40
Bed slope (˚)	<1	Gravel (2–4 mm)	10	15
Bank slope (L/R) (˚)	26/26	Sand (0.05–2 mm)	50	38
Riparian zone width (L/R) (m)	0/0	Silt/clay (<0.05 mm)	20	5
Water Quality	**Observed**	**Snags and Large Woody Debris[#]**		
Colour	Clear	Detritus (leaves, twigs)	L	L
Water surface	Normal	Sticks (<2 cm Ø)	N	N
Water odour	None	Branches (<15 cm Ø)	L	L
Temperature (˚C)	22.6	Logs (>15 cm Ø)	N	N
pH	7.6	**Other Attributes[#]**		
Electrical conductivity (µS/cm)	655	Periphyton	N	N
Dissolved oxygen (mg/L)	6.8	Moss	N	N
Dissolved oxygen (% saturation)	78	Filamentous algae	N	N
Turbidity (NTU)	280	Macrophytes	N	N
Alkalinity (mgCaCO3/L) (lab.)	82	Bank overhang veg.	S	L
Macroinvertebrates	Edge / Bed	Blanketing silt	N	N
Mean sample depth (m)	0.2 / 0.4	Substrate anoxia	N	N
Sample count	58 / 29	Canopy Cover (%)	2	2
No. of taxa	16 / 8	Shading (%)	50	50
SIGNAL 2 score	2.88 / 2.75			
AUSRIVAS O/E50 score	0.55 / 0.12			
AUSRIVAS band	B / C			
EPT %	6 / 0			

Flora and Vertebrate Fauna captured/observed		
Fauna		
Fish	***Common Name***	***Method****
Neosilurus hyrtlii	Hyrtl's tandan	S
Melanotaenia splendida	Eastern rainbowfish	S
Leiopotherapon unicolor	Spangled perch	S
Ambassis agassizii	Agassiz's glassifsh	S
Hypseleotris species 1	Midgley's carp gudgeon	S
Flora		
Riparian Trees	***Common Name***	***Abundance[#]***
Acacia harpophylla	Brigalow	M
Terminalia oblongata subsp. *volucris*	Rosewood	S
Macrophytes	***Common Name***	***Abundance[#]***
Eclipta prostrate	White eclipta	S
Grasses	***Common Name***	***Abundance[#]***
Echinochloa colona^	Awnless barnyard grass	S
Bothriochloa sp.	Bluegrass	M

Notes

* E = Backpack electrofisher (LR-24); F = Fyke net; B = Bait trap; O = Observation; M = Macroinvertebrate net (by-catch).
[#] N = None; L = 1–10 % (little); S = 10–50 % (some); M = 50–75 % (moderate); E = >75 % (extensive).
^ Introduced species.

Location:	Tributary of Kangaroo Creek	**Site Code:**	S7	**Date:**	05/05/2012	**Latitude:**	-21.1440	**Longitude:**	147.8575 GDA '94

Upstream	**Left Bank**	**Downstream**	**Right Bank**
			

Watercourse Description	
Wetland type	Riverine (creek)
Topography	Open depression
Seasonality	Ephemeral
Flow level	Low
Mean wetted width (m)	1
Bed slope (˚)	1
Bank slope (L/R) (˚)	40/40
Riparian zone width (L/R) (m)	30/30

Water Quality	**Observed**
Colour	Clear
Water surface	Normal
Water odour	None
Temperature (˚C)	19.0
pH	8.0
Electrical conductivity (µS/cm)	729
Dissolved oxygen (mg/L)	7.2
Dissolved oxygen (% saturation)	80.4
Turbidity (NTU)	33
Alkalinity (mgCaCO3/L) (lab.)	273

Macroinvertebrates	**Edge**	**Bed**
Mean sample depth (m)	0.05	0.03
Sample count	80	53
No. of taxa	16	9
SIGNAL 2 score	3.69	4.22
AUSRIVAS O/E50 score	0.55	0.49
AUSRIVAS band	B	B
EPT %	18	33

Habitat Description	**Edge**	**Bed**
Substrate (%)		
Bedrock	0	0
Boulders (>256 mm)	0	0
Cobbles (64–256 mm)	0	0
Pebbles (4–64 mm)	10	10
Gravel (2–4 mm)	60	70
Sand (0.05–2 mm)	20	20
Silt/clay (<0.05 mm)	10	0
Snags and Large Woody Debris[#]		
Detritus (leaves, twigs)	S	S
Sticks (<2 cm Ø)	S	L
Branches (<15 cm Ø)	S	L
Logs (>15 cm Ø)	L	L
Other attributes[#]		
Periphyton	N	N
Moss	N	N
Filamentous algae	N	N
Macrophytes	N	N
Bank overhang veg.	M	L
Blanketing silt	N	N
Substrate anoxia	N	N
Canopy Cover (%)	50	50
Shading (%)	75	75

Flora and Vertebrate Fauna captured/observed		
Fauna		
Fish	***Common Name***	***Method****
N/A	N/A	N/A
Flora		
Riparian Trees	***Common Name***	***Abundance***[#]
Eucalyptus tereticornis	Queensland blue gum	S
Corymbia tessellaris	Moreton Bay ash	S
Eucalyptus crebra	Narrow-leaved ironbark	L
Erythrina vespertilio	Bat's wing coral tree	L
Macrophytes	***Common Name***	***Abundance***[#]
Cyperus sp.	Sedge	L
Shrubs	***Common Name***	***Abundance***[#]
Ageratum houstonianum	Blue billygoat weed	L
Grasses	***Common Name***	***Abundance***[#]
Cynodon dactylon	Couch grass	E
Imperata cylindrica	Blady grass	M

Notes

* E = Backpack electrofisher (LR-24); F = Fyke net; B = Bait trap; O = Observation; M = Macroinvertebrate net (by-catch).

[#] N = None; L = 1–10 % (little); S = 10–50 % (some); M = 50–75 % (moderate); E = >75 % (extensive).

^ Introduced species.

Location:	Tributary of Kangaroo Creek	**Site Code:**	S8	**Date:**	05/05/2012	**Latitude:**	-21.1569	**Longitude:**	147.8538 GDA'94

Upstream	**Left bank**	**Downstream**	**Right bank**
			

Watercourse Description		**Habitat Description**	**Edge**	**Bed**
Wetland type	Riverine	**Substrate (%)**		
Topography	Open depression	Bedrock	0	0
Seasonality	Ephemeral	Boulders (>256 mm)	0	0
Flow level	Low	Cobbles (64–256 mm)	10	10
Mean wetted width (m)	6.75	Pebbles (4–64 mm)	0	0
Bed slope (˚)	<1	Gravel (2–4 mm)	25	30
Bank slope (L/R) (˚)	30/35	Sand (0.05–2 mm)	55	58
Riparian zone width (L/R) (m)	20/20	Silt/clay (<0.05 mm)	10	2
Water Quality	**Observed**	**Snags and Large Woody Debris**[#]		
Colour	Clear	Detritus (leaves, twigs)	M	L
Water surface	Normal	Sticks (<2 cm Ø)	S	L
Water odour	None	Branches (<15 cm Ø)	S	L
Temperature (˚C)	21.8	Logs (>15 cm Ø)	S	L
pH	7.9	**Other Attributes**[#]		
Electrical conductivity (µS/cm)	1414	Periphyton	L	L
Dissolved oxygen (mg/L)	6.3	Moss	N	N
Dissolved oxygen (% saturation)	73.8	Filamentous algae	L	L
Turbidity (NTU)	10	Macrophytes	N	N
Alkalinity (mgCaCO3/L) (lab.)	448	Bank overhang veg.	S	L
Macroinvertebrates	**Edge** / **Bed**	Blanketing silt	N	N
Mean sample depth (m)	0.25 / 0.4	Substrate anoxia	N	N
Sample count	35 / 43	Canopy Cover (%)	25	25
No. of taxa	13 / 10	Shading (%)	60	60
SIGNAL 2 score	3.54 / 3.80	**Notes**		
AUSRIVAS O/E50 score	0.62 / 0.79	* E = Backpack electrofisher (LR-24); F = Fyke net; B = Bait trap; O = Observation; M = Macroinvertebrate net (by-catch).		
AUSRIVAS band	B / A	[#] N = None; L = 1–10 % (little); S = 10–50 % (some); M = 50–75 % (moderate); E = >75 % (extensive).		
EPT %	16 / 20	^ Introduced species.		

Flora and Vertebrate Fauna captured/observed		
Fauna		
Fish	***Common Name***	***Method****
Leiopotherapon unicolor	Spangled perch	S, O
Melanotaenia splendida	Eastern rainbowfish	S
Flora		
Riparian Trees	***Common Name***	***Abundance***[#]
Eucalyptus tereticornis	Queensland blue gum	M
Grasses	***Common Name***	***Abundance***[#]
Cynodon dactylon	Couch grass	E

Location:	Tributary of Kangaroo Creek	Site Code:	S9	Date:	05/05/2012	Latitude:	-21.1340	Longitude:	147.8400 GDA'94

Upstream	Left Bank	Downstream	Right Bank
			

Watercourse Description		Habitat Description	Edge	Bed	Flora and Vertebrate Fauna captured/observed		
Wetland type	Riverine	**Substrate (%)**			**Fauna**		
Topography	Open depression	Bedrock	25	25	***Fish***	***Common Name***	***Method****
Seasonality	Ephemeral	Boulders (>256 mm)	5	5	N/A	N/A	N/A
Flow level	Low	Cobbles (64–256 mm)	5	5	***Other Vertebrates***	***Common Name***	***Method****
Mean wetted width (m)	1	Pebbles (4–64 mm)	5	5	*Limnodynastes tasmaniensis*	Spotted marsh frog	O
Bed slope (˚)	1	Gravel (2–4 mm)	25	30		**Flora**	
Bank slope (L/R) (˚)	26/11	Sand (0.05–2 mm)	30	30	***Riparian Trees***	***Common Name***	***Abundance****
Riparian zone width (L/R) (m)	15/20	Silt/clay (<0.05 mm)	5	0	*Eucalyptus tereticornis*	Queensland blue gum	S
Water Quality	**Observed**	**Snags and Large Woody Debris***			*Corymbia tessellaris*	Moreton Bay ash	S
Colour	Opaque	Detritus (leaves, twigs)	L	L	*Acacia harpophylla*	Brigalow	L
Water surface	Normal	Sticks (<2 cm Ø)	L	N	*Bauhinia* sp.	Bauhinia	L
Water odour	None	Branches (<15 cm Ø)	L	N	*Melaleuca bracteata*	Black tea-tree	L
Temperature (˚C)	24.0	Logs (>15 cm Ø)	L	L	***Macrophytes***	***Common Name***	***Abundance****
pH	8.3	**Other attributes***			*Juncus* sp.	Common rush	S
Electrical conductivity (µS/cm)	145	Periphyton	L	L	***Shrubs / Rushes***	***Common Name***	***Abundance****
Dissolved oxygen (mg/L)	6.5	Moss	N	N	*Stachytarpheta* sp.	Snakeweed	L
Dissolved oxygen (% saturation)	77.3	Filamentous algae	N	N	*Ageratum houstonianum*	Blue billygoat weed	L
Turbidity (NTU)	231	Macrophytes	S	N	***Grasses***	***Common Name***	***Abundance****
Alkalinity (mgCaCO3/L) (lab.)	28	Bank overhang veg.	M	L	*Imperata cylindrica*	Blady grass	M
Macroinvertebrates	**Edge** / **Bed**	Blanketing silt	N	N			
Mean sample depth (m)	0.2 / 0.15	Substrate anoxia	N	N			
Sample count	86 / 43	Canopy Cover (%)	30	30			
No. of taxa	17 / 15	Shading (%)	80	80			
SIGNAL 2 score	3.94 / 3.87	**Notes**					
AUSRIVAS O/E50 score	0.62 / 0.61	* E = Backpack electrofisher (LR-24); F = Fyke net; B = Bait trap; O = Observation; M = Macroinvertebrate net (by-catch).					
AUSRIVAS band	B / B	* N = None; L = 1–10 % (little); S = 10–50 % (some); M = 50–75 % (moderate); E = >75 % (extensive).					
EPT %	17 / 20	^ Introduced species.					

Location:	Tributary of Kangaroo Creek	**Site Code:**	S10	**Date:**	06/05/2012	**Latitude:**	-21.2123	**Longitude:**	147.8422 GDA'94

Upstream	**Left Bank**	**Downstream**	**Right Bank**
			

Watercourse Description		**Habitat Description**	**Edge**	**Bed**
Wetland type	Riverine	**Substrate (%)**		
Topography	Open deression	Bedrock	0	0
Seasonality	Ephemeral	Boulders (>256 mm)	0	0
Flow level	Moderate	Cobbles (64–256 mm)	0	0
Mean wetted width (m)	4	Pebbles (4–64 mm)	10	5
Bed slope (˚)	1	Gravel (2–4 mm)	60	85
Bank slope (L/R) (˚)	63/63	Sand (0.05–2 mm)	10	5
Riparian zone width (L/R) (m)	10/10	Silt/clay (<0.05 mm)	20	5
Water Quality	**Observed**	**Snags and Large Woody Debris[#]**		
Colour	Opaque	Detritus (leaves, twigs)	S	L
Water surface	Normal	Sticks (<2 cm Ø)	S	L
Water odour	None	Branches (<15 cm Ø)	S	L
Temperature (˚C)	16.6	Logs (>15 cm Ø)	L	L
pH	8.2	**Other Attributes[#]**		
Electrical conductivity (µS/cm)	278	Periphyton	N	N
Dissolved oxygen (mg/L)	5.58	Moss	N	N
Dissolved oxygen (% saturation)	58	Filamentous algae	N	N
Turbidity (NTU)	751	Macrophytes	S	N
Alkalinity (mgCaCO3/L) (lab.)	61	Bank overhang veg.	E	L
Macroinvertebrates	**Edge** / **Bed**	Blanketing silt	N	N
Mean sample depth (m)	0.2 / 0.5	Substrate anoxia	N	N
Sample count	57 / 32	Canopy Cover (%)	25	25
No. of taxa	16 / 11	Shading (%)	40	40
SIGNAL 2 score	3.00 / 4.00			
AUSRIVAS O/E50 score	0.62 / 0.98			
AUSRIVAS band	B / A			
EPT %	12 / 17			

Flora and Vertebrate Fauna captured/observed		
Fauna		
Fish	***Common Name***	***Method****
Melanotaenia splendida	Eastern rainbowfish	S
Leiopotherapon unicolor	Spangled perch	S
Flora		
Riparian Trees	***Common Name***	***Abundance[#]***
Acacia harpophylla	Brigalow	M
Santalum album	Sandalwood	S
Bauhinia sp.	Bauhinia	L
Shrubs	***Common Name***	***Abundance[#]***
Xanthium pungens^	Noogoora burr	S
Parthenium hysterophorus	Parthenium	L
Opuntia stricta^	Prickly pear	L
Macrophytes	***Common Name***	**Abundance[#]**
Cyperus sp.	Sedge	S
Grasses	***Common Name***	***Abundance[#]***
Bothriochloa sp.	Bluegrass	E
Echinochloa colona^	Awnless barnyard grass	S
Panicum sp.	Panic grass	L
Notes		
* E = Backpack electrofisher (LR-24); F = Fyke net; B = Bait trap; O = Observation; M = Macroinvertebrate net (by-catch). [#] N = None; L = 1–10 % (little); S = 10–50 % (some); M = 50–75 % (moderate); E = >75 % (extensive). ^ Introduced species.		

ATTACHMENT B – EPBC PROTECTED MATTERS REPORT

EPBC Act Protected Matters Report

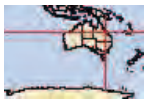
This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected.

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

Information about the EPBC Act including significance guidelines, forms and application process details can be found at http://www.environment.gov.au/epbc/assessmentsapprovals/index.html

Report created: 23/02/12 10:39:41

Coordinates
Buffer: 1.0Km



Summary

Matters of National Environment Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance - see http://www.environment.gov.au/epbc/assessmentsapprovals/guidelines/index.html

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Areas:	None
Threatened Ecological Communities:	3
Threatened Species:	23
Migratory Species:	15

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 and the heritage values of a place on the Register of the National Estate. Information on the new heritage laws can be found at http://www.environment.gov.au/heritage/index.html

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.

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. Information on EPBC Act permit requirements and application forms can be found at http://www.environment.gov.

Commonwealth Lands:	None
Commonwealth Heritage Places:	None
Listed Marine Species:	14
Whales and Other Cetaceans:	None
Critical Habitats:	None
Commonwealth Reserves:	None

Extra Information

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

Place on the RNE:	None
State and Territory Reserves:	2
Regional Forest Agreements:	None
Invasive Species:	12
Nationally Important Wetlands:	None

Details

Matters of National Environmental Significance

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	Endangered	Community likely to

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
Highlands and the northern Fitzroy Basin		occur within area
Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions	Endangered	Community likely to occur within area

Threatened Species [Resource Information]

Name	Status	Type of Presence
BIRDS		
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
Neochmia ruficauda ruficauda Star Finch (eastern), Star Finch (southern) [26027]	Endangered	Species or species habitat likely to occur within area
Poephila cincta cincta Black-throated Finch (southern) [64447]	Endangered	Species or species habitat may occur within area
Rostratula australis Australian Painted Snipe [77037]	Vulnerable	Species or species habitat likely to occur within area
MAMMALS		
Dasyurus hallucatus Northern Quoll [331]	Endangered	Species or species habitat likely to occur within area
Nyctophilus timoriensis (South-eastern form) Greater Long-eared Bat, South-eastern Long-eared Bat [66888]	Vulnerable	Species or species habitat may occur within area
Pteropus conspicillatus Spectacled Flying-fox [185]	Vulnerable	Species or species habitat may occur within area
OTHER		
Cycas ophiolitica [55797]	Endangered	Species or species habitat likely to occur within area
PLANTS		
Acacia ramiflora [7242]	Vulnerable	Species or species habitat may occur within area
Cajanus mareebensis [8635]	Endangered	Species or species habitat may occur within area
Croton magneticus [16681]	Vulnerable	Species or species habitat likely to occur within area
Dichanthium queenslandicum King Blue-grass [5481]	Vulnerable	Species or species habitat likely to occur within area
Digitaria porrecta Finger Panic Grass [12768]	Endangered	Species or species habitat likely to occur within area
Eucalyptus raveretiana Black Ironbox [16344]	Vulnerable	Species or species

Name	Status	Type of Presence
		habitat likely to occur within area
Leucopogon cuspidatus [9739]	Vulnerable	Species or species habitat likely to occur within area
REPTILES		
Delma labialis Striped-tailed Delma, Single-striped Delma [25930]	Vulnerable	Species or species habitat may occur within area
Denisonia maculata Ornamental Snake [1193]	Vulnerable	Species or species habitat known to occur within area
Egernia rugosa Yakka Skink [1420]	Vulnerable	Species or species habitat may occur within area
Lerista allanae Allan's Lerista, Retro Slider [1378]	Endangered	Species or species habitat may occur within area
Lerista vittata Mount Cooper Striped Lerista [1308]	Vulnerable	Species or species habitat may occur within area
Paradelma orientalis Brigalow Scaly-foot [59134]	Vulnerable	Species or species habitat known to occur within area
Rheodytes leukops Fitzroy River Turtle, Fitzroy Tortoise, Fitzroy Turtle [1761]	Vulnerable	Species or species habitat may occur within area

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 may occur within area
Ardea alba Great Egret, White Egret [59541]		Species or species habitat may occur within area
Ardea ibis Cattle Egret [59542]		Species or species habitat may occur within area
Migratory Marine Species		
Crocodylus porosus Salt-water Crocodile, Estuarine Crocodile [1774]		Species or species habitat likely to occur within area
Migratory Terrestrial Species		
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat likely to occur within area
Hirundapus caudacutus White-throated Needletail [682]		Species or species habitat may occur within area
Hirundo rustica Barn Swallow [662]		Species or species habitat may occur within area
Merops ornatus Rainbow Bee-eater [670]		Species or species

Name	Threatened	Type of Presence
		habitat may occur within area
Monarcha melanopsis Black-faced Monarch [609]		Breeding may occur within area
Myiagra cyanoleuca Satin Flycatcher [612]		Species or species habitat likely to occur within area
Migratory Wetlands Species		
Ardea alba Great Egret, White Egret [59541]		Species or species habitat may occur within area
Ardea ibis Cattle Egret [59542]		Species or species habitat may occur within area
Gallinago hardwickii Latham's Snipe, Japanese Snipe [863]		Species or species habitat may occur within area
Nettapus coromandelianus albipennis Australian Cotton Pygmy-goose [25979]		Species or species habitat may occur within area
Rostratula benghalensis s. lat. Painted Snipe [889]	Vulnerable*	Species or species habitat likely to occur within area

Other Matters Protected by the EPBC Act

Listed Marine Species [Resource Information]

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

Name	Threatened	Type of Presence
Birds		
Anseranas semipalmata Magpie Goose [978]		Species or species habitat may occur within area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat may occur within area
Ardea alba Great Egret, White Egret [59541]		Species or species habitat may occur within area
Ardea ibis Cattle Egret [59542]		Species or species habitat may occur within area
Gallinago hardwickii Latham's Snipe, Japanese Snipe [863]		Species or species habitat may occur within area
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat likely to occur within area
Hirundapus caudacutus White-throated Needletail [682]		Species or species habitat may occur within area
Hirundo rustica Barn Swallow [662]		Species or species habitat may occur within

Name	Threatened	Type of Presence
		area
Merops ornatus		
Rainbow Bee-eater [670]		Species or species habitat may occur within area
Monarcha melanopsis		
Black-faced Monarch [609]		Breeding may occur within area
Myiagra cyanoleuca		
Satin Flycatcher [612]		Species or species habitat likely to occur within area
Nettapus coromandelianus albipennis		
Australian Cotton Pygmy-goose [25979]		Species or species habitat may occur within area
Rostratula benghalensis s. lat.		
Painted Snipe [889]	Vulnerable*	Species or species habitat likely to occur within area
Reptiles		
Crocodylus porosus		
Salt-water Crocodile, Estuarine Crocodile [1774]		Species or species habitat likely to occur within area

Extra Information

State and Territory Reserves [Resource Information]

Name	State
Blackjack Mountain	QLD
Newlands	QLD

Invasive Species [Resource Information]

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

Name	Status	Type of Presence
Frogs		
Bufo marinus		
Cane Toad [1772]		Species or species habitat likely to occur within area
Mammals		
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
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

Name	Status	Type of Presence
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
Hymenachne amplexicaulis		
Hymenachne, Olive Hymenachne, Water Stargrass, West Indian Grass, West Indian Marsh Grass [31754]		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
Parkinsonia aculeata		
Parkinsonia, Jerusalem Thorn, Jelly Bean Tree, Horse Bean [12301]		Species or species habitat likely to occur within area
Parthenium hysterophorus		
Parthenium Weed, Bitter Weed, Carrot Grass, False Ragweed [19566]		Species or species habitat likely to occur within area

Coordinates

-20.90156 147.62248,-20.89912 148.10683,-21.56741 148.11183,-21.56994 147.62529,
-20.90156 147.62248

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 Heritage and Register of National Estate properties, Wetlands of International 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

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

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.

For species where the distributions are well known, maps are digitised from sources such as recovery plans and detailed habitat studies. Where appropriate, core breeding, foraging and roosting areas are indicated under 'type of presence'. For species whose distributions are less well known, point locations are collated from government wildlife authorities, museums, and non-government organisations; bioclimatic distribution models are generated and these validated by experts. In some cases, the distribution maps are based solely on expert knowledge.

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

ATTACHMENT C – ANALYTICAL WATER CHEMISTRY RESULTS

Environmental Division

CERTIFICATE OF ANALYSIS

Work Order	: **EB1212382**	Page	: 1 of 4
Client	: **UNIDEL GROUP PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: MR DAVE MOORE	Contact	: Customer Services
Address	: GPO BOX 1957 BRISBANE QLD, AUSTRALIA 4001	Address	: 32 Shand Street Stafford QLD Australia 4053
E-mail	: d.moore@unidel.com.au	E-mail	: Brisbane.Enviro.Services@alsglobal.com
Telephone	: 07 3229 2500	Telephone	: +61 7 3243 7222
Facsimile	: ----	Facsimile	: +61 7 3243 7218
Project	: BYCOO2	QC Level	: NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Order number	: ----		
C-O-C number	: ----	Date Samples Received	: 09-MAY-2012
Sampler	: DAVE MOORE	Issue Date	: 22-MAY-2012
Site	: BYERWEN		
		No. of samples received	: 9
Quote number	: BN/129/12	No. of samples analysed	: 9

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. All pages of this report have been checked and approved for release.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

NATA Accredited Laboratory 825

Accredited for compliance with ISO/IEC 17025.

Signatories

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

Signatories	*Position*	*Accreditation Category*
Jonathon Angell	Inorganic Coordinator	Brisbane Inorganics
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics
Stephen Hislop	Senior Inorganic Chemist	Brisbane Inorganics

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.

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

Analytical Results

Sub-Matrix: **WATER**

Compound	CAS Number	LOR	Unit	Client sample ID: S1	S2	S3	S4	S6
				Client sampling date / time: 01-MAY-2012 15:00	02-MAY-2012 15:00	03-MAY-2012 15:00	03-MAY-2012 15:00	04-MAY-2012 15:00
				EB1212382-001	EB1212382-002	EB1212382-003	EB1212382-004	EB1212382-005
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	**38**	**88**	**30**	**50**	**82**
Total Alkalinity as CaCO3	----	1	mg/L	**38**	**88**	**30**	**50**	**82**
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	<1	<1	<1	<1	**111**
ED045G: Chloride Discrete analyser								
Chloride	16887-00-6	1	mg/L	**31**	**6**	**11**	**8**	**86**
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	**4**	**15**	**2**	**5**	**30**
Magnesium	7439-95-4	1	mg/L	**5**	**7**	**2**	**3**	**19**
Sodium	7440-23-5	1	mg/L	**25**	**9**	**14**	**14**	**70**
Potassium	7440-09-7	1	mg/L	**2**	**7**	**3**	**2**	**6**
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	**0.06**	**0.05**	**0.05**	**0.10**	**0.05**
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	----	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	**0.04**	<0.01	<0.01	**0.14**	**0.01**
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	**0.04**	<0.01	<0.01	**0.15**	**0.01**
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	**0.7**	**1.2**	**0.9**	**0.8**	**0.8**
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser								
^ **Total Nitrogen as N**	----	0.1	mg/L	**0.7**	**1.2**	**0.9**	**1.0**	**0.8**
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	0.01	mg/L	**0.08**	**0.13**	**0.12**	**0.54**	**0.13**
EK071G: Reactive Phosphorus as P by discrete analyser								
Reactive Phosphorus as P	----	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
EN055: Ionic Balance								
Total Anions	----	0.01	meq/L	**1.63**	**1.93**	**0.91**	**1.22**	**6.38**
Total Cations	----	0.01	meq/L	**1.75**	**1.90**	**0.95**	**1.16**	**6.26**
Ionic Balance	----	0.01	%	----	----	----	----	**0.93**

Analytical Results

Sub-Matrix: **WATER**

Compound	CAS Number	LOR	Unit	Client sample ID: S7	S8	S9	S10	----
				Client sampling date / time: 05-MAY-2012 15:00	05-MAY-2012 15:00	05-MAY-2012 15:00	06-MAY-2012 15:00	----
				EB1212382-006	EB1212382-007	EB1212382-008	EB1212382-009	----
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	<1	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	<1	<1	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	273	448	28	51	----
Total Alkalinity as CaCO3	----	1	mg/L	273	448	28	51	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	<1	<1	<1	<1	----
ED045G: Chloride Discrete analyser								
Chloride	16887-00-6	1	mg/L	52	174	15	37	----
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	29	61	3	11	----
Magnesium	7439-95-4	1	mg/L	37	64	4	6	----
Sodium	7440-23-5	1	mg/L	55	101	13	25	----
Potassium	7440-09-7	1	mg/L	3	5	2	3	----
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	0.04	0.04	0.05	0.06	----
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	----	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	0.02	0.01	0.02	0.14	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	0.02	0.01	0.02	0.15	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	0.3	0.3	0.6	0.6	----
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser								
^ Total Nitrogen as N	----	0.1	mg/L	0.3	0.3	0.6	0.8	----
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	0.01	mg/L	<0.01	0.06	0.12	0.02	----
EK071G: Reactive Phosphorus as P by discrete analyser								
Reactive Phosphorus as P	----	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	----
EN055: Ionic Balance								
Total Anions	----	0.01	meq/L	6.92	13.9	0.98	2.06	----
Total Cations	----	0.01	meq/L	6.96	12.8	1.10	2.21	----
Ionic Balance	----	0.01	%	0.26	3.86	----	----	----

Environmental Division

QUALITY CONTROL REPORT

Work Order	: **EB1212382**	Page	: 1 of 7
Client	: **UNIDEL GROUP PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: MR DAVE MOORE	Contact	: Customer Services
Address	: GPO BOX 1957 BRISBANE QLD, AUSTRALIA 4001	Address	: 32 Shand Street Stafford QLD Australia 4053
E-mail	: d.moore@unidel.com.au	E-mail	: Brisbane.Enviro.Services@alsglobal.com
Telephone	: 07 3229 2500	Telephone	: +61 7 3243 7222
Facsimile	: ----	Facsimile	: +61 7 3243 7218
Project	: BYCOO2	QC Level	: NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Site	: BYERWEN		
C-O-C number	: ----	Date Samples Received	: 09-MAY-2012
Sampler	: DAVE MOORE	Issue Date	: 22-MAY-2012
Order number	: ----		
		No. of samples received	: 9
Quote number	: BN/129/12	No. of samples analysed	: 9

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. All pages of this report have been checked and approved for release.

This Quality Control Report contains the following information:

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

NATA Accredited Laboratory 825

Accredited for compliance with ISO/IEC 17025.

Signatories

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

Signatories	*Position*	*Accreditation Category*
Jonathon Angell	Inorganic Coordinator	Brisbane Inorganics
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics
Stephen Hislop	Senior Inorganic Chemist	Brisbane Inorganics

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.

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

Laboratory Duplicate (DUP) Report

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

Sub-Matrix: **WATER**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Recovery Limits (%)*
ED037P: Alkalinity by PC Titrator (QC Lot: 2306337)									
EB1212212-002	Anonymous	ED037-P: Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	0.0	No Limit
		ED037-P: Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	0.0	No Limit
		ED037-P: Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	49	48	2.7	0% - 20%
		ED037-P: Total Alkalinity as CaCO3	----	1	mg/L	49	48	2.7	0% - 20%
EB1212382-002	S2	ED037-P: Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	0.0	No Limit
		ED037-P: Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	0.0	No Limit
		ED037-P: Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	88	87	0.0	0% - 20%
		ED037-P: Total Alkalinity as CaCO3	----	1	mg/L	88	87	0.0	0% - 20%
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA (QC Lot: 2299582)									
EB1212382-001	S1	ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	<1	<1	0.0	No Limit
EB1212411-013	Anonymous	ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	<1	<1	0.0	No Limit
ED045G: Chloride Discrete analyser (QC Lot: 2299580)									
EB1212382-001	S1	ED045G: Chloride	16887-00-6	1	mg/L	31	31	0.0	0% - 20%
EB1212411-013	Anonymous	ED045G: Chloride	16887-00-6	1	mg/L	<1	<1	0.0	No Limit
ED093F: Dissolved Major Cations (QC Lot: 2299574)									
EB1212382-001	S1	ED093F: Calcium	7440-70-2	1	mg/L	4	4	0.0	No Limit
		ED093F: Magnesium	7439-95-4	1	mg/L	5	5	0.0	No Limit
		ED093F: Sodium	7440-23-5	1	mg/L	25	25	0.0	0% - 20%
		ED093F: Potassium	7440-09-7	1	mg/L	2	2	0.0	No Limit
EB1212411-013	Anonymous	ED093F: Calcium	7440-70-2	1	mg/L	18	18	0.0	0% - 50%
		ED093F: Magnesium	7439-95-4	1	mg/L	3	3	0.0	No Limit
		ED093F: Sodium	7440-23-5	1	mg/L	6	6	0.0	No Limit
		ED093F: Potassium	7440-09-7	1	mg/L	<1	<1	0.0	No Limit
EK055G: Ammonia as N by Discrete Analyser (QC Lot: 2313264)									
EB1212382-001	S1	EK055G: Ammonia as N	7664-41-7	0.01	mg/L	0.06	0.05	19.2	No Limit
EB1212544-002	Anonymous	EK055G: Ammonia as N	7664-41-7	0.01	mg/L	0.03	0.02	52.2	No Limit
EK057G: Nitrite as N by Discrete Analyser (QC Lot: 2299576)									
EB1212382-001	S1	EK057G: Nitrite as N	----	0.01	mg/L	<0.01	<0.01	0.0	No Limit
EB1212411-013	Anonymous	EK057G: Nitrite as N	----	0.01	mg/L	<0.01	<0.01	0.0	No Limit
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QC Lot: 2313263)									
EB1212382-001	S1	EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	0.04	0.05	0.0	No Limit
EB1212544-002	Anonymous	EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	0.02	0.01	0.0	No Limit
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QC Lot: 2311366)									
EB1212382-001	S1	EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	0.7	0.6	0.0	No Limit
EB1212558-001	Anonymous	EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	4.7	4.9	4.0	0% - 20%

Sub-Matrix: **WATER**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Recovery Limits (%)*
EK067G: Total Phosphorus as P by Discrete Analyser (QC Lot: 2311367)									
EB1212382-001	S1	EK067G: Total Phosphorus as P	----	0.01	mg/L	0.08	0.05	41.2	No Limit
EB1212558-001	Anonymous	EK067G: Total Phosphorus as P	----	0.01	mg/L	8.75	8.62	1.5	0% - 20%
EK071G: Reactive Phosphorus as P by discrete analyser (QC Lot: 2299578)									
EB1212382-001	S1	EK071G: Reactive Phosphorus as P	----	0.01	mg/L	<0.01	<0.01	0.0	No Limit
EB1212411-013	Anonymous	EK071G: Reactive Phosphorus as P	----	0.01	mg/L	0.03	0.03	0.0	No Limit

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

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

Sub-Matrix: **WATER**

				Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Recovery Limits (%)	
Method: Compound	CAS Number	LOR	Unit	Result	Concentration	LCS	Low	High
ED037P: Alkalinity by PC Titrator (QCLot: 2306337)								
ED037-P: Total Alkalinity as CaCO3	----	1	mg/L	----	200 mg/L	97.3	88	112
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA (QCLot: 2299582)								
ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	<1	25 mg/L	112	70	130
ED045G: Chloride Discrete analyser (QCLot: 2299580)								
ED045G: Chloride	16887-00-6	1	mg/L	<1	1000 mg/L	91.9	70	128
ED093F: Dissolved Major Cations (QCLot: 2299574)								
ED093F: Calcium	7440-70-2	1	mg/L	<1	----	----	----	----
ED093F: Magnesium	7439-95-4	1	mg/L	<1	----	----	----	----
ED093F: Sodium	7440-23-5	1	mg/L	<1	----	----	----	----
ED093F: Potassium	7440-09-7	1	mg/L	<1	----	----	----	----
EK055G: Ammonia as N by Discrete Analyser (QCLot: 2313264)								
EK055G: Ammonia as N	7664-41-7	0.01	mg/L	<0.01	0.5 mg/L	96.6	70	120
EK057G: Nitrite as N by Discrete Analyser (QCLot: 2299576)								
EK057G: Nitrite as N	----	0.01	mg/L	<0.01	0.5 mg/L	105	78	128
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QCLot: 2313263)								
EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	0.5 mg/L	97.8	70	124
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QCLot: 2311366)								
EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	<0.1	10.0 mg/L	82.7	70	115
EK067G: Total Phosphorus as P by Discrete Analyser (QCLot: 2311367)								
EK067G: Total Phosphorus as P	----	0.01	mg/L	<0.01	4.2 mg/L	94.0	76	117
EK071G: Reactive Phosphorus as P by discrete analyser (QCLot: 2299578)								
EK071G: Reactive Phosphorus as P	----	0.01	mg/L	<0.01	0.5 mg/L	104	81	121

Matrix Spike (MS) Report

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

Sub-Matrix: **WATER**

				Matrix Spike (MS) Report			
				Spike	Spike Recovery (%)	Recovery Limits (%)	
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Concentration	MS	Low	High
ED045G: Chloride Discrete analyser (QCLot: 2299580)							
EB1212382-002	S2	ED045G: Chloride	16887-00-6	400 mg/L	88.4	70	130
EK055G: Ammonia as N by Discrete Analyser (QCLot: 2313264)							
EB1212382-002	S2	EK055G: Ammonia as N	7664-41-7	0.4 mg/L	78.2	70	130
EK057G: Nitrite as N by Discrete Analyser (QCLot: 2299576)							
EB1212382-002	S2	EK057G: Nitrite as N	----	0.4 mg/L	112	70	130
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QCLot: 2313263)							
EB1212382-002	S2	EK059G: Nitrite + Nitrate as N	----	0.4 mg/L	74.0	70	130
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QCLot: 2311366)							
EB1212382-002	S2	EK061G: Total Kjeldahl Nitrogen as N	----	5 mg/L	90.2	70	130
EK067G: Total Phosphorus as P by Discrete Analyser (QCLot: 2311367)							
EB1212382-002	S2	EK067G: Total Phosphorus as P	----	1.0 mg/L	100	70	130
EK071G: Reactive Phosphorus as P by discrete analyser (QCLot: 2299578)							
EB1212382-002	S2	EK071G: Reactive Phosphorus as P	----	0.4 mg/L	115	70	130

Matrix Spike (MS) and Matrix Spike Duplicate (MSD) Report

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

Sub-Matrix: **WATER**

				Matrix Spike (MS) and Matrix Spike Duplicate (MSD) Report						
				Spike	Spike Recovery (%)		Recovery Limits (%)		RPDs (%)	
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Concentration	MS	MSD	Low	High	Value	Control Limit
ED045G: Chloride Discrete analyser (QCLot: 2299580)										
EB1212382-002	S2	ED045G: Chloride	16887-00-6	400 mg/L	88.4	----	70	130	----	----
EK055G: Ammonia as N by Discrete Analyser (QCLot: 2313264)										
EB1212382-002	S2	EK055G: Ammonia as N	7664-41-7	0.4 mg/L	78.2	----	70	130	----	----
EK057G: Nitrite as N by Discrete Analyser (QCLot: 2299576)										
EB1212382-002	S2	EK057G: Nitrite as N	----	0.4 mg/L	112	----	70	130	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QCLot: 2313263)										
EB1212382-002	S2	EK059G: Nitrite + Nitrate as N	----	0.4 mg/L	74.0	----	70	130	----	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QCLot: 2311366)										
EB1212382-002	S2	EK061G: Total Kjeldahl Nitrogen as N	----	5 mg/L	90.2	----	70	130	----	----
EK067G: Total Phosphorus as P by Discrete Analyser (QCLot: 2311367)										
EB1212382-002	S2	EK067G: Total Phosphorus as P	----	1.0 mg/L	100	----	70	130	----	----

Sub-Matrix: **WATER**

				Matrix Spike (MS) and Matrix Spike Duplicate (MSD) Report						
				Spike	Spike Recovery (%)		Recovery Limits (%)		RPDs (%)	
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Concentration	MS	MSD	Low	High	Value	Control Limit
EK071G: Reactive Phosphorus as P by discrete analyser (QCLot: 2299578)										
EB1212382-002	S2	EK071G: Reactive Phosphorus as P	----	0.4 mg/L	115	----	70	130	----	----

Environmental Division

INTERPRETIVE QUALITY CONTROL REPORT

Work Order	: **EB1212382**	Page	: 1 of 10
Client	: UNIDEL GROUP PTY LTD	Laboratory	: Environmental Division Brisbane
Contact	: MR DAVE MOORE	Contact	: Customer Services
Address	: GPO BOX 1957 BRISBANE QLD, AUSTRALIA 4001	Address	: 32 Shand Street Stafford QLD Australia 4053
E-mail	: d.moore@unidel.com.au	E-mail	: Brisbane.Enviro.Services@alsglobal.com
Telephone	: 07 3229 2500	Telephone	: +61 7 3243 7222
Facsimile	: ----	Facsimile	: +61 7 3243 7218
Project	: BYCOO2	QC Level	: NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Site	: BYERWEN		
C-O-C number	: ----	Date Samples Received	: 09-MAY-2012
Sampler	: DAVE MOORE	Issue Date	: 22-MAY-2012
Order number	: ----		
		No. of samples received	: 9
Quote number	: BN/129/12	No. of samples analysed	: 9

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. All pages of this report have been checked and approved for release.

This Interpretive Quality Control Report contains the following information:

- Analysis Holding Time Compliance
- Quality Control Parameter Frequency Compliance
- Brief Method Summaries
- Summary of Outliers

Analysis Holding Time Compliance

The following report summarises extraction / preparation and analysis times and compares with recommended holding times. Dates reported represent first date of extraction or analysis and precludes subsequent dilutions and reruns. Information is also provided re the sample container (preservative) from which the analysis aliquot was taken. Elapsed period to analysis represents number of days from sampling where no extraction / digestion is involved or period from extraction / digestion where this is present. For composite samples, sampling date is assumed to be that of the oldest sample contributing to the composite. Sample date for laboratory produced leachates is assumed as the completion date of the leaching process. Outliers for holding time are based on USEPA SW 846, APHA, AS and NEPM (1999). A listing of breaches is provided in the Summary of Outliers.

Holding times for leachate methods (excluding elutriates) vary according to the analytes being determined on the resulting solution. For non-volatile analytes, the holding time compliance assessment compares the leach date with the shortest analyte holding time for the equivalent soil method. These soil holding times are: Organics (14 days); Mercury (28 days) & other metals (180 days). A recorded breach therefore does not guarantee a breach for all non-volatile parameters.

Matrix: **WATER**

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

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
ED037P: Alkalinity by PC Titrator							
Clear Plastic Bottle - Natural (ED037-P) S1	**01-MAY-2012**	---	15-MAY-2012	----	**16-MAY-2012**	15-MAY-2012	×
Clear Plastic Bottle - Natural (ED037-P) S2	**02-MAY-2012**	---	16-MAY-2012	----	**16-MAY-2012**	16-MAY-2012	✓
Clear Plastic Bottle - Natural (ED037-P) S3, S4	**03-MAY-2012**	---	17-MAY-2012	----	**16-MAY-2012**	17-MAY-2012	✓
Clear Plastic Bottle - Natural (ED037-P) S6	**04-MAY-2012**	---	18-MAY-2012	----	**16-MAY-2012**	18-MAY-2012	✓
Clear Plastic Bottle - Natural (ED037-P) S7, S8, S9	**05-MAY-2012**	---	19-MAY-2012	----	**16-MAY-2012**	19-MAY-2012	✓
Clear Plastic Bottle - Natural (ED037-P) S10	**06-MAY-2012**	---	20-MAY-2012	----	**16-MAY-2012**	20-MAY-2012	✓
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA							
Clear Plastic Bottle - Natural (ED041G) S1	**01-MAY-2012**	---	29-MAY-2012	----	**11-MAY-2012**	29-MAY-2012	✓
Clear Plastic Bottle - Natural (ED041G) S2	**02-MAY-2012**	---	30-MAY-2012	----	**11-MAY-2012**	30-MAY-2012	✓
Clear Plastic Bottle - Natural (ED041G) S3, S4	**03-MAY-2012**	---	31-MAY-2012	----	**11-MAY-2012**	31-MAY-2012	✓
Clear Plastic Bottle - Natural (ED041G) S6	**04-MAY-2012**	---	01-JUN-2012	----	**11-MAY-2012**	01-JUN-2012	✓
Clear Plastic Bottle - Natural (ED041G) S7, S8, S9	**05-MAY-2012**	---	02-JUN-2012	----	**11-MAY-2012**	02-JUN-2012	✓
Clear Plastic Bottle - Natural (ED041G) S10	**06-MAY-2012**	---	03-JUN-2012	----	**11-MAY-2012**	03-JUN-2012	✓

Matrix: **WATER**

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

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
ED045G: Chloride Discrete analyser							
Clear Plastic Bottle - Natural (ED045G) S1	**01-MAY-2012**	---	29-MAY-2012	----	**11-MAY-2012**	29-MAY-2012	✓
Clear Plastic Bottle - Natural (ED045G) S2	**02-MAY-2012**	---	30-MAY-2012	----	**11-MAY-2012**	30-MAY-2012	✓
Clear Plastic Bottle - Natural (ED045G) S3, S4	**03-MAY-2012**	---	31-MAY-2012	----	**11-MAY-2012**	31-MAY-2012	✓
Clear Plastic Bottle - Natural (ED045G) S6	**04-MAY-2012**	---	01-JUN-2012	----	**11-MAY-2012**	01-JUN-2012	✓
Clear Plastic Bottle - Natural (ED045G) S7, S8, S9	**05-MAY-2012**	---	02-JUN-2012	----	**11-MAY-2012**	02-JUN-2012	✓
Clear Plastic Bottle - Natural (ED045G) S10	**06-MAY-2012**	---	03-JUN-2012	----	**11-MAY-2012**	03-JUN-2012	✓
ED093F: Dissolved Major Cations							
Clear Plastic Bottle - Natural (ED093F) S1	**01-MAY-2012**	---	08-MAY-2012	----	**11-MAY-2012**	08-MAY-2012	×
Clear Plastic Bottle - Natural (ED093F) S2	**02-MAY-2012**	---	09-MAY-2012	----	**11-MAY-2012**	09-MAY-2012	×
Clear Plastic Bottle - Natural (ED093F) S3, S4	**03-MAY-2012**	---	10-MAY-2012	----	**11-MAY-2012**	10-MAY-2012	×
Clear Plastic Bottle - Natural (ED093F) S6	**04-MAY-2012**	---	11-MAY-2012	----	**11-MAY-2012**	11-MAY-2012	✓
Clear Plastic Bottle - Natural (ED093F) S7, S8, S9	**05-MAY-2012**	---	12-MAY-2012	----	**11-MAY-2012**	12-MAY-2012	✓
Clear Plastic Bottle - Natural (ED093F) S10	**06-MAY-2012**	---	13-MAY-2012	----	**11-MAY-2012**	13-MAY-2012	✓
EK055G: Ammonia as N by Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK055G) S1	**01-MAY-2012**	---	29-MAY-2012	----	**21-MAY-2012**	29-MAY-2012	✓
Clear Plastic Bottle - Sulfuric Acid (EK055G) S2	**02-MAY-2012**	---	30-MAY-2012	----	**21-MAY-2012**	30-MAY-2012	✓
Clear Plastic Bottle - Sulfuric Acid (EK055G) S3, S4	**03-MAY-2012**	---	31-MAY-2012	----	**21-MAY-2012**	31-MAY-2012	✓
Clear Plastic Bottle - Sulfuric Acid (EK055G) S6	**04-MAY-2012**	---	01-JUN-2012	----	**21-MAY-2012**	01-JUN-2012	✓
Clear Plastic Bottle - Sulfuric Acid (EK055G) S7, S8, S9	**05-MAY-2012**	---	02-JUN-2012	----	**21-MAY-2012**	02-JUN-2012	✓
Clear Plastic Bottle - Sulfuric Acid (EK055G) S10	**06-MAY-2012**	---	03-JUN-2012	----	**21-MAY-2012**	03-JUN-2012	✓

Matrix: **WATER**

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

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EK057G: Nitrite as N by Discrete Analyser							
Clear Plastic Bottle - Natural (EK057G) S1	**01-MAY-2012**	---	03-MAY-2012	----	**11-MAY-2012**	03-MAY-2012	×
Clear Plastic Bottle - Natural (EK057G) S2	**02-MAY-2012**	---	04-MAY-2012	----	**11-MAY-2012**	04-MAY-2012	×
Clear Plastic Bottle - Natural (EK057G) S3, S4	**03-MAY-2012**	---	05-MAY-2012	----	**11-MAY-2012**	05-MAY-2012	×
Clear Plastic Bottle - Natural (EK057G) S6	**04-MAY-2012**	---	06-MAY-2012	----	**11-MAY-2012**	06-MAY-2012	×
Clear Plastic Bottle - Natural (EK057G) S7, S8, S9	**05-MAY-2012**	---	07-MAY-2012	----	**11-MAY-2012**	07-MAY-2012	×
Clear Plastic Bottle - Natural (EK057G) S10	**06-MAY-2012**	---	08-MAY-2012	----	**11-MAY-2012**	08-MAY-2012	×
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK059G) S1	**01-MAY-2012**	---	29-MAY-2012	----	**21-MAY-2012**	29-MAY-2012	✓
Clear Plastic Bottle - Sulfuric Acid (EK059G) S2	**02-MAY-2012**	---	30-MAY-2012	----	**21-MAY-2012**	30-MAY-2012	✓
Clear Plastic Bottle - Sulfuric Acid (EK059G) S3, S4	**03-MAY-2012**	---	31-MAY-2012	----	**21-MAY-2012**	31-MAY-2012	✓
Clear Plastic Bottle - Sulfuric Acid (EK059G) S6	**04-MAY-2012**	---	01-JUN-2012	----	**21-MAY-2012**	01-JUN-2012	✓
Clear Plastic Bottle - Sulfuric Acid (EK059G) S7, S8, S9	**05-MAY-2012**	---	02-JUN-2012	----	**21-MAY-2012**	02-JUN-2012	✓
Clear Plastic Bottle - Sulfuric Acid (EK059G) S10	**06-MAY-2012**	---	03-JUN-2012	----	**21-MAY-2012**	03-JUN-2012	✓
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK061G) S1	**01-MAY-2012**	**18-MAY-2012**	29-MAY-2012	✓	**18-MAY-2012**	29-MAY-2012	✓
Clear Plastic Bottle - Sulfuric Acid (EK061G) S2	**02-MAY-2012**	**18-MAY-2012**	30-MAY-2012	✓	**18-MAY-2012**	30-MAY-2012	✓
Clear Plastic Bottle - Sulfuric Acid (EK061G) S3, S4	**03-MAY-2012**	**18-MAY-2012**	31-MAY-2012	✓	**18-MAY-2012**	31-MAY-2012	✓
Clear Plastic Bottle - Sulfuric Acid (EK061G) S6	**04-MAY-2012**	**18-MAY-2012**	01-JUN-2012	✓	**18-MAY-2012**	01-JUN-2012	✓
Clear Plastic Bottle - Sulfuric Acid (EK061G) S7, S8, S9	**05-MAY-2012**	**18-MAY-2012**	02-JUN-2012	✓	**18-MAY-2012**	02-JUN-2012	✓
Clear Plastic Bottle - Sulfuric Acid (EK061G) S10	**06-MAY-2012**	**18-MAY-2012**	03-JUN-2012	✓	**18-MAY-2012**	03-JUN-2012	✓

Matrix: **WATER**

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

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EK067G: Total Phosphorus as P by Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK067G) S1	**01-MAY-2012**	**18-MAY-2012**	29-MAY-2012	✓	**18-MAY-2012**	29-MAY-2012	✓
Clear Plastic Bottle - Sulfuric Acid (EK067G) S2	**02-MAY-2012**	**18-MAY-2012**	30-MAY-2012	✓	**18-MAY-2012**	30-MAY-2012	✓
Clear Plastic Bottle - Sulfuric Acid (EK067G) S3, S4	**03-MAY-2012**	**18-MAY-2012**	31-MAY-2012	✓	**18-MAY-2012**	31-MAY-2012	✓
Clear Plastic Bottle - Sulfuric Acid (EK067G) S6	**04-MAY-2012**	**18-MAY-2012**	01-JUN-2012	✓	**18-MAY-2012**	01-JUN-2012	✓
Clear Plastic Bottle - Sulfuric Acid (EK067G) S7, S8, S9	**05-MAY-2012**	**18-MAY-2012**	02-JUN-2012	✓	**18-MAY-2012**	02-JUN-2012	✓
Clear Plastic Bottle - Sulfuric Acid (EK067G) S10	**06-MAY-2012**	**18-MAY-2012**	03-JUN-2012	✓	**18-MAY-2012**	03-JUN-2012	✓
EK071G: Reactive Phosphorus as P by discrete analyser							
Clear Plastic Bottle - Natural (EK071G) S1	**01-MAY-2012**	**---**	03-MAY-2012	----	**11-MAY-2012**	03-MAY-2012	×
Clear Plastic Bottle - Natural (EK071G) S2	**02-MAY-2012**	**---**	04-MAY-2012	----	**11-MAY-2012**	04-MAY-2012	×
Clear Plastic Bottle - Natural (EK071G) S3, S4	**03-MAY-2012**	**---**	05-MAY-2012	----	**11-MAY-2012**	05-MAY-2012	×
Clear Plastic Bottle - Natural (EK071G) S6	**04-MAY-2012**	**---**	06-MAY-2012	----	**11-MAY-2012**	06-MAY-2012	×
Clear Plastic Bottle - Natural (EK071G) S7, S8, S9	**05-MAY-2012**	**---**	07-MAY-2012	----	**11-MAY-2012**	07-MAY-2012	×
Clear Plastic Bottle - Natural (EK071G) S10	**06-MAY-2012**	**---**	08-MAY-2012	----	**11-MAY-2012**	08-MAY-2012	×

Quality Control Parameter Frequency Compliance

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

Matrix: **WATER**

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

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Laboratory Duplicates (DUP)							
Alkalinity by PC Titrator	ED037-P	2	18	**11.1**	**10.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Ammonia as N by Discrete analyser	EK055G	2	19	**10.5**	**10.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Chloride by Discrete Analyser	ED045G	2	20	**10.0**	**10.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Major Cations - Dissolved	ED093F	2	20	**10.0**	**10.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	2	20	**10.0**	**10.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Nitrite as N by Discrete Analyser	EK057G	2	20	**10.0**	**10.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Reactive Phosphorus as P-By Discrete Analyser	EK071G	2	20	**10.0**	**10.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	2	20	**10.0**	**10.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	2	20	**10.0**	**10.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Total Phosphorus as P By Discrete Analyser	EK067G	2	20	**10.0**	**10.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Laboratory Control Samples (LCS)							
Alkalinity by PC Titrator	ED037-P	1	18	**5.6**	**5.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Ammonia as N by Discrete analyser	EK055G	1	19	**5.3**	**5.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Chloride by Discrete Analyser	ED045G	2	20	**10.0**	**10.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	20	**5.0**	**5.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Nitrite as N by Discrete Analyser	EK057G	1	20	**5.0**	**5.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Reactive Phosphorus as P-By Discrete Analyser	EK071G	1	20	**5.0**	**5.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	1	20	**5.0**	**5.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	1	20	**5.0**	**5.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Total Phosphorus as P By Discrete Analyser	EK067G	1	20	**5.0**	**5.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Method Blanks (MB)							
Ammonia as N by Discrete analyser	EK055G	1	19	**5.3**	**5.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Chloride by Discrete Analyser	ED045G	1	20	**5.0**	**5.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Major Cations - Dissolved	ED093F	1	20	**5.0**	**5.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	20	**5.0**	**5.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Nitrite as N by Discrete Analyser	EK057G	1	20	**5.0**	**5.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Reactive Phosphorus as P-By Discrete Analyser	EK071G	1	20	**5.0**	**5.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	1	20	**5.0**	**5.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	1	20	**5.0**	**5.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Total Phosphorus as P By Discrete Analyser	EK067G	1	20	**5.0**	**5.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Matrix Spikes (MS)							
Ammonia as N by Discrete analyser	EK055G	1	19	**5.3**	**5.0**	✓	ALS QCS3 requirement
Chloride by Discrete Analyser	ED045G	1	20	**5.0**	**5.0**	✓	ALS QCS3 requirement
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	20	**5.0**	**5.0**	✓	ALS QCS3 requirement
Nitrite as N by Discrete Analyser	EK057G	1	20	**5.0**	**5.0**	✓	ALS QCS3 requirement
Reactive Phosphorus as P-By Discrete Analyser	EK071G	1	20	**5.0**	**5.0**	✓	ALS QCS3 requirement
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	1	20	**5.0**	**5.0**	✓	ALS QCS3 requirement
Total Phosphorus as P By Discrete Analyser	EK067G	1	20	**5.0**	**5.0**	✓	ALS QCS3 requirement

Brief Method Summaries

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

Analytical Methods	Method	Matrix	Method Descriptions
Alkalinity by PC Titrator	ED037-P	WATER	APHA 21st ed., 2320 B This procedure determines alkalinity by automated measurement (e.g. PC Titrate) using pH 4.5 for indicating the total alkalinity end-point. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2)
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	WATER	APHA 21st ed., 4500-SO4 Sulfate ions are converted to a barium sulfate suspension in an acetic acid medium with barium chloride. Light absorbance of the BaSO4 suspension is measured by a photometer and the SO4-2 concentration is determined by comparison of the reading with a standard curve. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2)
Chloride by Discrete Analyser	ED045G	WATER	APHA 21st ed., 4500 Cl - G.The thiocyanate ion is liberated from mercuric thiocyanate through sequestration of mercury by the chloride ion to form non-ionised mercuric chloride.in the presence of ferric ions the librated thiocynate forms highly-coloured ferric thiocynate which is measured at 480 nm APHA 21st edition seal method 2 017-1-L april 2003
Major Cations - Dissolved	ED093F	WATER	Major Cations is determined based on APHA 21st ed., 3120; USEPA SW 846 - 6010 The ICPAES technique ionises the 0.45um filtered sample atoms emitting a characteristic spectrum. This spectrum is then compared against matrix matched standards for quantification. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2) Sodium Absorption Ratio is calculated from Ca, Mg and Na which determined by ALS in house method QWI-EN/ED093F. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2) Total Hardness is calculated based on APHA 21st ed., 2340 B. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2)
Ammonia as N by Discrete analyser	EK055G	WATER	APHA 21st ed., 4500-NH3 G Ammonia is determined by direct colorimetry by Discrete Analyser. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2)
Nitrite as N by Discrete Analyser	EK057G	WATER	APHA 21st ed., 4500-NO2- B. Nitrite is determined by direct colourimetry by Discrete Analyser. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2)
Nitrate as N by Discrete Analyser	EK058G	WATER	APHA 21st ed., 4500-NO3- F. Nitrate is reduced to nitrite by way of a cadmium reduction column followed by quantification by Discrete Analyser. Nitrite is determined seperately by direct colourimetry and result for Nitrate calculated as the difference between the two results. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2)
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	WATER	APHA 21st ed., 4500-NO3- F. Combined oxidised Nitrogen (NO2+NO3) is determined by Cadmium Reduction and direct colourimetry by Discrete Analyser. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2)
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	WATER	APHA 21st ed., 4500-Norg D. 25mL water samples are digested using a traditional Kjeldahl digestion followed by determination by Discrete Analyser. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2)
Total Nitrogen as N (TKN + Nox) By Discrete Analyser	EK062G	WATER	APHA 21st ed., 4500-Norg / 4500-NO3-. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2)
Total Phosphorus as P By Discrete Analyser	EK067G	WATER	APHA 21st ed., 4500-P B&F This procedure involves sulphuric acid digestion of a 100mL sample to break phosphorus down to orthophosphate. The orthophosphate reacts with ammonium molybdate and antimony potassium tartrate to form a complex which is then reduced and its concentration measured at 880nm using Discrete Analyser. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2)

Analytical Methods	Method	Matrix	Method Descriptions
Reactive Phosphorus as P-By Discrete Analyser	EK071G	WATER	APHA 21st ed., 4500-P F Ammonium molybdate and potassium antimonyl tartrate reacts in acid medium with othophosphate to form a heteropoly acid -phosphomolybdic acid - which is reduced to intensely coloured molybdenum blue by ascorbic acid. Quantification is by Discrete Analyser. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2)
Ionic Balance by PCT DA and Turbi SO4 DA	EN055 - PG	WATER	APHA 21st Ed. 1030F. The Ionic Balance is calculated based on the major Anions and Cations. The major anions include Alkalinity, Chloride and Sulfate which determined by PCT and DA. The Cations are determined by Turbi SO4 by DA. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2)

Preparation Methods	Method	Matrix	Method Descriptions
TKN/TP Digestion	EK061/EK067	WATER	APHA 21st ed., 4500 Norg - D; APHA 21st ed., 4500 P - H. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2)

Summary of Outliers

Outliers : Quality Control Samples

The following report highlights outliers flagged in the Quality Control (QC) Report. Surrogate recovery limits are static and based on USEPA SW846 or ALS-QWI/EN/38 (in the absence of specific USEPA limits). This report displays QC Outliers (breaches) only.

Duplicates, Method Blanks, Laboratory Control Samples and Matrix Spikes

- **For all matrices, no Method Blank value outliers occur.**
- **For all matrices, no Duplicate outliers occur.**
- **For all matrices, no Laboratory Control outliers occur.**
- **For all matrices, no Matrix Spike outliers occur.**

Regular Sample Surrogates

- **For all regular sample matrices, no surrogate recovery outliers occur.**

Outliers : Analysis Holding Time Compliance

This report displays Holding Time breaches only. Only the respective Extraction / Preparation and/or Analysis component is/are displayed.

Matrix: **WATER**

Method	Extraction / Preparation			Analysis		
Container / Client Sample ID(s)	Date extracted	Due for extraction	Days overdue	Date analysed	Due for analysis	Days overdue
ED037P: Alkalinity by PC Titrator						
Clear Plastic Bottle - Natural S1	----	----	----	16-MAY-2012	15-MAY-2012	**1**
ED093F: Dissolved Major Cations						
Clear Plastic Bottle - Natural S1	----	----	----	11-MAY-2012	08-MAY-2012	**3**
Clear Plastic Bottle - Natural S2	----	----	----	11-MAY-2012	09-MAY-2012	**2**
Clear Plastic Bottle - Natural S3, S4	----	----	----	11-MAY-2012	10-MAY-2012	**1**
EK057G: Nitrite as N by Discrete Analyser						
Clear Plastic Bottle - Natural S1	----	----	----	11-MAY-2012	03-MAY-2012	**8**
Clear Plastic Bottle - Natural S2	----	----	----	11-MAY-2012	04-MAY-2012	**7**
Clear Plastic Bottle - Natural S3, S4	----	----	----	11-MAY-2012	05-MAY-2012	**6**
Clear Plastic Bottle - Natural S6	----	----	----	11-MAY-2012	06-MAY-2012	**5**
Clear Plastic Bottle - Natural S7, S8, S9	----	----	----	11-MAY-2012	07-MAY-2012	**4**

Matrix: **WATER**

Method / Container / Client Sample ID(s)	Extraction / Preparation			Analysis		
	Date extracted	Due for extraction	Days overdue	Date analysed	Due for analysis	Days overdue
EK057G: Nitrite as N by Discrete Analyser - Analysis Holding Time Compliance						
Clear Plastic Bottle - Natural S10	----	----	----	11-MAY-2012	08-MAY-2012	**3**
EK071G: Reactive Phosphorus as P by discrete analyser						
Clear Plastic Bottle - Natural S1	----	----	----	11-MAY-2012	03-MAY-2012	**8**
Clear Plastic Bottle - Natural S2	----	----	----	11-MAY-2012	04-MAY-2012	**7**
Clear Plastic Bottle - Natural S3, S4	----	----	----	11-MAY-2012	05-MAY-2012	**6**
Clear Plastic Bottle - Natural S6	----	----	----	11-MAY-2012	06-MAY-2012	**5**
Clear Plastic Bottle - Natural S7, S8, S9	----	----	----	11-MAY-2012	07-MAY-2012	**4**
Clear Plastic Bottle - Natural S10	----	----	----	11-MAY-2012	08-MAY-2012	**3**

Outliers : Frequency of Quality Control Samples

The following report highlights breaches in the Frequency of Quality Control Samples.

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

Environmental Division

SAMPLE RECEIPT NOTIFICATION (SRN)

Comprehensive Report

Work Order	: **EB1212382**		
Client	: **UNIDEL GROUP PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: MR DAVE MOORE	Contact	: Customer Services
Address	: GPO BOX 1957 BRISBANE QLD, AUSTRALIA 4001	Address	: 32 Shand Street Stafford QLD Australia 4053
E-mail	: d.moore@unidel.com.au	E-mail	: Brisbane.Enviro.Services@alsglobal.com
Telephone	: 07 3229 2500	Telephone	: +61 7 3243 7222
Facsimile	: ----	Facsimile	: +61 7 3243 7218
Project	: BYCOO2	Page	: 1 of 3
Order number	: ----		
C-O-C number	: ----	Quote number	: EB2012UNIDELS0004 (BN/129/12)
Site	: BYERWEN		
Sampler	: DAVE MOORE	QC Level	: NEPM 1999 Schedule B(3) and ALS QCS3 requirement

Dates

Date Samples Received	: 09-MAY-2012	Issue Date	: 11-MAY-2012 11:50
Client Requested Due Date	: 23-MAY-2012	Scheduled Reporting Date	: **22-MAY-2012**

Delivery Details

Mode of Delivery	: Client Drop off	Temperature	: 10.0°C
No. of coolers/boxes	: 1 MEDIUM	No. of samples received	: 9
Security Seal	: Intact.	No. of samples analysed	: 9

General Comments

- This report contains the following information:
  - Sample Container(s)/Preservation Non-Compliances
  - Summary of Sample(s) and Requested Analysis
  - Proactive Holding Time Report
  - Requested Deliverables
- **Samples received in appropriately pretreated and preserved containers.**
- **Breaches in recommended extraction / analysis holding times (if any) are displayed overleaf in the Proactive Holding Time Report table.**
- Discounted Package Prices apply only when specific ALS Group Codes ('W', 'S', 'NT' suites) are referenced on COCs.
- Please direct any turn around / technical queries to the laboratory contact designated above.
- Please direct any queries related to sample condition / numbering / breakages to Matt Goodwin.
- Analytical work for this work order will be conducted at ALS Brisbane.
- Sample Disposal - Aqueous (14 days), Solid (90 days) from date of completion of work order.

Sample Container(s)/Preservation Non-Compliances

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

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

Summary of Sample(s) and Requested Analysis

Some items described below may be part of a laboratory process neccessary for the execution of client requested tasks. Packages may contain additional analyses, such as the determination of moisture content and preparation tasks, that are included in the package.
If no sampling time is provided, the sampling time will default to 15:00 on the date of sampling. If no sampling date is provided, the sampling date will be assumed by the laboratory for processing purposes and will be shown bracketed without a time component.

Matrix: **WATER**

Laboratory sample ID	Client sampling date / time	Client sample ID	WATER - EN055 - PG Ionic Balance by ED037P, ED041G, ED045G & ED093F)	WATER - NT-01 Major Cations (Ca, Mg, Na, K)	WATER - NT-02 Major Anions (Chloride, Sulphate, Alkalinity)	WATER - NT-08A Total Nitrogen + NO2 + NO3 + NH3 + Total P + Reactive P
EB1212382-001	01-MAY-2012 15:00	S1	✓	✓	✓	✓
EB1212382-002	02-MAY-2012 15:00	S2	✓	✓	✓	✓
EB1212382-003	03-MAY-2012 15:00	S3	✓	✓	✓	✓
EB1212382-004	03-MAY-2012 15:00	S4	✓	✓	✓	✓
EB1212382-005	04-MAY-2012 15:00	S6	✓	✓	✓	✓
EB1212382-006	05-MAY-2012 15:00	S7	✓	✓	✓	✓
EB1212382-007	05-MAY-2012 15:00	S8	✓	✓	✓	✓
EB1212382-008	05-MAY-2012 15:00	S9	✓	✓	✓	✓
EB1212382-009	06-MAY-2012 15:00	S10	✓	✓	✓	✓

Proactive Holding Time Report

The following table summarises breaches of recommended holding times that have occurred prior to samples/instructions being received at the laboratory.

Matrix: **WATER**

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

Method		Due for extraction	Due for analysis	Samples Received		Instructions Received	
Client Sample ID(s)	Container			Date	Evaluation	Date	Evaluation
ED093F: Major Cations - Dissolved							
S1	Clear Plastic Bottle - Natural	08-MAY-2012	----	09-MAY-2012	×	----	----
EK057G: Nitrite as N by Discrete Analyser							
S1	Clear Plastic Bottle - Natural	03-MAY-2012	----	09-MAY-2012	×	----	----
S10	Clear Plastic Bottle - Natural	08-MAY-2012	----	09-MAY-2012	×	----	----
S2	Clear Plastic Bottle - Natural	04-MAY-2012	----	09-MAY-2012	×	----	----
S3	Clear Plastic Bottle - Natural	05-MAY-2012	----	09-MAY-2012	×	----	----
S4	Clear Plastic Bottle - Natural	05-MAY-2012	----	09-MAY-2012	×	----	----
S6	Clear Plastic Bottle - Natural	06-MAY-2012	----	09-MAY-2012	×	----	----
S7	Clear Plastic Bottle - Natural	07-MAY-2012	----	09-MAY-2012	×	----	----
S8	Clear Plastic Bottle - Natural	07-MAY-2012	----	09-MAY-2012	×	----	----
S9	Clear Plastic Bottle - Natural	07-MAY-2012	----	09-MAY-2012	×	----	----
EK071G: Reactive Phosphorus as P-By Discrete Analyser							
S1	Clear Plastic Bottle - Natural	03-MAY-2012	----	09-MAY-2012	×	----	----
S10	Clear Plastic Bottle - Natural	08-MAY-2012	----	09-MAY-2012	×	----	----
S2	Clear Plastic Bottle - Natural	04-MAY-2012	----	09-MAY-2012	×	----	----
S3	Clear Plastic Bottle - Natural	05-MAY-2012	----	09-MAY-2012	×	----	----
S4	Clear Plastic Bottle - Natural	05-MAY-2012	----	09-MAY-2012	×	----	----
S6	Clear Plastic Bottle - Natural	06-MAY-2012	----	09-MAY-2012	×	----	----
S7	Clear Plastic Bottle - Natural	07-MAY-2012	----	09-MAY-2012	×	----	----
S8	Clear Plastic Bottle - Natural	07-MAY-2012	----	09-MAY-2012	×	----	----
S9	Clear Plastic Bottle - Natural	07-MAY-2012	----	09-MAY-2012	×	----	----

Requested Deliverables

MR DAVE MOORE

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

MR TIBOR DE JONG

- A4 - AU Tax Invoice (INV)	Email	tdejong@unidel.com.au

CHAIN OF CUSTODY DOCUMENTATION

CLIENT: BYERWEN COAL C/- UNIDEL PTY LTD
ADDRESS / OFFICE: BRISBANE
PROJECT MANAGER (PM): JEROMY CLARIDGE
PROJECT ID: BYC002
SITE: BYERWEN P.O. NO.:
RESULTS REQUIRED (Date): 23/5/12 QUOTE NO.: BN/134/12

SAMPLER: DAVE MOORE
MOBILE: 0408 674 299
PHONE:
EMAIL REPORT TO: dmoore@unidel.com.au
EMAIL INVOICE TO: (if different to report)

ALS Laboratory Group

FOR LABORATORY USE ONLY
COOLER SEAL (circle appropriate)
Intact: Yes No N/A
SAMPLE TEMPERATURE
CHILLED: Yes No

COMMENTS / SPECIAL HANDLING / STORAGE OR DISPOSAL:

ANALYSIS REQUIRED including SUITES (note - suite codes must be listed to attract suite prices)

Notes: e.g. Highly contaminated samples
e.g. "High PAHs expected".
Extra volume for QC or trace LORs etc.

ALS ID	SAMPLE ID	MATRIX	DATE	Time	Type / Code	Total bottles	SUITE NT-8A (TN, TKN, NO_x, NO_2)	NO_3, NH_3, TP, REACTIVE P	SUITE NT-2 (MAJOR ANIONS)	SUITE NT-1 (MAJOR CATIONS)
1	S1	W	1/5		P, SP	2		X	X	X
2	S2	W	2/5		P, SP	2	X	X	X	X
3	S3	W	3/5		P, SP	2	X	X	X	X
4	S4	W	3/5		P, SP	2	X	X	X	X
5	S6	W	4/5		P, SP	2	X	X	X	X
6	S7	W	5/5		P, SP	2	X	X	X	X
7	S8	W	5/5		P, SP	2	X	X	X	X
8	S9	W	5/5		P, SP	2	X	X	X	X
9	S10	W	6/5		P, SP	2	X	X	X	X

Environmental Division
Brisbane
Work Order
EB1212382

Telephone : +61-7-3243 7222

RELINQUISHED BY:

Name: DAVE MOORE	Date: 9/5/12
Of: UNIDEL	Time: 0900
Name:	Date:
Of:	Time:

RECEIVED BY

Name: OTTO	Date: 09/05/12
Of: ALS	Time: 09:30
Name:	Date:
Of:	Time:

METHOD OF SHIPMENT

Con' Note No:

Transport Co:

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

ATTACHMENT D – MACROINVERTEBRATE IDENTIFICATIONS

Taxa Code	Class/Order	Family/Sub-family	SIGNAL 2 Value	UNID01/01 - S1 Bed	UNID01/02 - S1 Edge	UNID01/03 - S2 Bed	UNID01/04 - S2 Edge	UNID01/05 - S3	UNID01/06 - S4 Bed	UNID01/07 - S4 Edge	UNID01/08 - S5	UNID01/09 - S6 Bed	UNID01/10 - S6 Edge	UNID01/11 - S7 Bed	UNID01/12 - S7 Edge	UNID01/13 - S8 Bed	UNID01/14 - S8 Edge	UNID01/15 - S9 Bed	UNID01/16 - S9 Edge	UNID01/17 - S10 Bed	UNID01/18 - S10 Edg
MM999999	Acarina	sp.	6			16	6	6		4						4	5			3	
OP029999	Amphipoda	Ceinidae	2																		
OP039999	Amphipoda	Eusiridae	7																		
OP099999	Amphipoda	Melitidae	7																		
OP079999	Amphipoda	Neoniphargidae	4																		
OP049999	Amphipoda	Paracalliopidae	3																		
OP069999	Amphipoda	Paramelitidae	4																		
OP089999	Amphipoda	Perthiidae	4																		
OP999999	Amphipoda	sp.	3																		
OP019999	Amphipoda	Talitridae	3																		
OD029999	Anostraca	Branchiopodidae	N/A								3										
KP029999	Bivalvia	Corbiculidae	4																		
KP999999	Bivalvia	Hyriidae	3	1								1									
KP039999	Bivalvia	Sphaeriidae	5																		
QCAM9999	Coleoptera	Brentidae	3																		
QC059999	Coleoptera	Carabidae	3																		
QCAH9999	Coleoptera	Chrysomelidae	2																		
QCZZ9999	Coleoptera	Coleoptera	5																		
QCAN9999	Coleoptera	Curculionidae	2					1													
QC099999	Coleoptera	Dytiscidae	2	2	20	9	24	4	12	11		2	15	2	15		7	5	7	1	6
QC349999	Coleoptera	Elmidae	7										2								
QC109999	Coleoptera	Gyrinidae	4		1	4	7			10				1	4			2	1		
QC069999	Coleoptera	Haliplidae	2														1				1
QC369999	Coleoptera	Heteroceridae	1																		
QC139999	Coleoptera	Hydraenidae	3		1							1	2						2		1
QCAO9999	Coleoptera	Hydrochidae	4		1								2		4		4	1	7		
QC119999	Coleoptera	Hydrophilidae	2		9		1	3				3	3								1
QC079999	Coleoptera	Hygrobiidae	1																		
QC359999	Coleoptera	Limnichidae	4																		
QC039999	Coleoptera	Microsporidae	7																		
QC089999	Coleoptera	Noteridae	4																		
QC379999	Coleoptera	Psephenidae	6																1		
QC399999	Coleoptera	Ptilodactylidae	10																		
QC209999	Coleoptera	Scirtidae	6																		
	Coleoptera	Sperchidae					10														
QC189999	Coleoptera	Staphylinidae	3																		
QA999999	Collembola	sp.	1																		
OK999999	Crustacea	Branchiura	1																		
OG999999	Crustacea	Cladocera	N/A			11	17			1											1
OF999999	Crustacea	Conchostraca	1																		
OJ999999	Crustacea	Copepoda	N/A			13	6													3	3
OH999999	Crustacea	Ostracoda	N/A							1											
OT019999	Decapoda	Atyidae	3		4																
OX619999	Decapoda	Grapsidae	7																		
OX019999	Decapoda	Hymenosomatidae	3								1					1		1			
OT029999	Decapoda	Palaemonidae	4		1		1		1			4									
OV019999	Decapoda	Parastacidae	4		1			1	1			1				1		1	1	3	3
OX519999	Decapoda	Sundatelphusidae	3																		
QDAA9999	Diptera	Aphroteniinae	8																		
QD229999	Diptera	Athericidae	8																		
QD049999	Diptera	Blephariceridae	10																		
QD099999	Diptera	Ceratopogonidae	4					1						2	4	1			2		
QD059999	Diptera	Chaoboridae	2																		
QDAZ9999	Diptera	Chironomidae	3																		
QDAJ9999	Diptera	Chironominae	3	3	2	53	93	43	4				2			5	1	2		2	3
QD079999	Diptera	Culicidae	1				1	1		1			2								1
QDAB9999	Diptera	Diamesinae	6																		
QD069999	Diptera	Dixidae	7																		
QD369999	Diptera	Dolichopodidae	3																		
QD359999	Diptera	Empididae	5																		
QD789999	Diptera	Ephydridae	2																		
QD899999	Diptera	Muscidae	1																		
QDAF9999	Diptera	Orthocladiinae	4													1		1	1		
QD209999	Diptera	Pelecorhynchidae	10																		
QDAD9999	Diptera	Podonominae	6																		
QD129999	Diptera	Psychodidae	3																		
QD459999	Diptera	Sciomyzidae	2																		
QD109999	Diptera	Simuliidae	5	15										3				2			
QD999999	Diptera	sp.	3																		
QD249999	Diptera	Stratiomyidae	2												2						
QD439999	Diptera	Syrphidae	2																		
QD239999	Diptera	Tabanidae	3					1							6						
QD039999	Diptera	Tanyderidae	6																		
QDAE9999	Diptera	Tanypodinae	4	1	6		1	4	3	2			1		2	19	1	3	9	12	
QD119999	Diptera	Thaumaleidae	7																		
QD019999	Diptera	Tipulidae	5	1											1						
QE049999	Ephemeroptera	Ameletopsidae	7																		
QE029999	Ephemeroptera	Baetidae	5	5	3	12	17	15		1					2					2	
QE089999	Ephemeroptera	Caenidae	4	2	6				1	1			1	8	13	8	2	4	2	1	3
QE059999	Ephemeroptera	Coloburiscidae	8																		
QE069999	Ephemeroptera	Leptophlebiidae	8		2									7	4			1	8		
QE039999	Ephemeroptera	Oniscigastridae	8																		
QE099999	Ephemeroptera	Prosopistomatidae	4																		
QE019999	Ephemeroptera	Siphlonuridae	10																		
QE999999	Ephemeroptera	sp.	9																		
QE079999	Ephemeroptera	Teloganodidae	9																		
KG069999	Gastropoda	Ancylidae	4															1			
KG039999	Gastropoda	Bithyniidae	3									1	3								
KG029999	Gastropoda	Hydrobiidae	4																		
KG059999	Gastropoda	Lymnaeidae	1					1													
KG089999	Gastropoda	Physidae	1			1	2	5													

KG079999	Gastropoda	Planorbidae	2					7					1								
KG999999	Gastropoda	sp.	1																		
KG049999	Gastropoda	Thiaridae	4																		
KG019999	Gastropoda	Viviparidae	4																		
QH629999	Hemiptera	Belostomatidae	1				5	4													
QH659999	Hemiptera	Corixidae	2			50	25	5	1	14			2		4	1	1	2	1	2	7
QH649999	Hemiptera	Gelastocoridae	5																		2
QH579999	Hemiptera	Gerridae	4		5		5	1		8					4		7		17		3
QH539999	Hemiptera	Hebridae	3																		
QH549999	Hemiptera	Hydrometridae	3																		
QH589999	Hemiptera	Leptopodidae	N/A																		
QH529999	Hemiptera	Mesoveliidae	2																		
QH669999	Hemiptera	Naucoridae	2																		
QH619999	Hemiptera	Nepidae	3					1	1				1								
QH679999	Hemiptera	Notonectidae	1				36	19	12	18		16	12	21	9		1	16	23		4
QH639999	Hemiptera	Ochteridae	2																		
QH689999	Hemiptera	Pleidae	2					3													
QH609999	Hemiptera	Saldidae	1																		
QH999999	Hemiptera	sp.	2																		
QH569999	Hemiptera	Veliidae	3		2		4	2		5			8				2		1		17
LH059999	Hirudinea	Erpobdellidae	1																		
LH019999	Hirudinea	Glossiphoniidae	1																		
LH049999	Hirudinea	Ornithobdellidae	1																		
LH039999	Hirudinea	Richardsonianidae	4					1		1											
LH999999	Hirudinea	sp.	1																		
IB029999	Hydrazoa	Clavidae	3																		
IB019999	Hydrazoa	Hydridae	2																		
OR019999	Isopoda	Amphisopidae	1																		
OR129999	Isopoda	Cirolanidae	2																		
OR189999	Isopoda	Janiridae	3																		
OR029999	Isopoda	Mesamphisopidae	3																		
OR259999	Isopoda	Oniscidae	2																		
OR059999	Isopoda	Phreatoicidae	4																		
OR039999	Isopoda	Phreatoicopsidae	2																		
OR999999	Isopoda	sp.	2																		
OR139999	Isopoda	Sphaeromatidae	1																		
QL019999	Lepidoptera	Crambidae	3												1						
QK019999	Mecoptera	Nannochoristidae	9																		
QM019999	Megaloptera	Corydalidae	7																		
QM029999	Megaloptera	Sialidae	5																		
II999999	Nematoda	sp.	3																		
IJ019999	Nematomorpha	Gordiidae	5																		
IH019999	Nemertea	Tetrastemmatidae	7																		
QN049999	Neuroptera	Neurorthidae	9																		
QN039999	Neuroptera	Osmylidae	7																		
QN059999	Neuroptera	Sisyridae	3																		
QN999999	Neuroptera	sp.	6																		
QO129999	Odonata	Aeshnidae	4					5													
QO279999	Odonata	Austrocorduliidae	10																		
QO189999	Odonata	Chorismagrionidae	7																		
QO029999	Odonata	Coenagrionidae	2					1													
QO289999	Odonata	Cordulephyidae	5																		
QO169999	Odonata	Corduliidae	5														1				
QO099999	Odonata	Diphlebiidae	6																		
QO999998	Odonata	Epiproctophora	3																		
QO139999	Odonata	Gomphidae	5		1																
QO249999	Odonata	Gomphomacromiidae	5																		
QO309999	Odonata	Hemicorduliidae	5																		
QO019999	Odonata	Hemiphlebiidae	N/A																		
QO069999	Odonata	Hypolestidae	9																		
QO039999	Odonata	Isostictidae	3																		
QO059999	Odonata	Lestidae	1																		
QO179999	Odonata	Libellulidae	4		2	3	13	10		2				7	5				1		
QO229999	Odonata	Lindeniidae	3																		
QO269999	Odonata	Macromiidae	8																		
QO079999	Odonata	Megapodagrionidae	5																		
QO049999	Odonata	Disparoneurinae	4																		
QO999999	Odonata	sp.	3																		
QO089999	Odonata	Synlestidae	7																		
QO239999	Odonata	Synthemistidae	2																		
QO219999	Odonata	Telephlebiidae	9																		
QO319999	Odonata	Urothemistidae	1																		
QO999997	Odonata	Zygoptera	3		1		1	1													
LO999999	Oligochaeta	Oligochaeta	2					2					1								
QP029999	Plecoptera	Austroperlidae	10																		
QP019999	Plecoptera	Eustheniidae	10																		
QP039999	Plecoptera	Gripopterygidae	8																		
QP049999	Plecoptera	Notonemouridae	6																		
IA019999	Porifera	Spongillidae	3																		
ON029999	Syncarida	Koonungidae	1																		
QT169999	Trichoptera	Antipodoeciidae	8																		
QT239999	Trichoptera	Atriplectididae	7																		
QT249999	Trichoptera	Calamoceratidae	7																		
QT189999	Trichoptera	Calocidae	9																		
QT159999	Trichoptera	Conoesucidae	7																		
QT269999	Trichoptera	Dipseudopsidae	9																		
QT089999	Trichoptera	Ecnomidae	4													2				2	
QT029999	Trichoptera	Glossosomatidae	9																		
QT199999	Trichoptera	Helicophidae	10																		
QT179999	Trichoptera	Helicopsychidae	8																		
QT019999	Trichoptera	Hydrobiosidae	8																		
QT069999	Trichoptera	Hydropsychidae	6	2	1	1												1			
QT039999	Trichoptera	Hydroptilidae	4																		
QT209999	Trichoptera	Kokiriidae	3																		
QT259999	Trichoptera	Leptoceridae	6		1		3	4	1					2			2		2	1	1
QT109999	Trichoptera	Limnephilidae	8																		
QT229999	Trichoptera	Odontoceridae	7																		
QT129999	Trichoptera	Oeconesidae	8																		
QT049999	Trichoptera	Philopotamidae	8																		
QT219999	Trichoptera	Philorheithridae	8																		

QT079999	Trichoptera	Polycentropodidae	7																		
QT099999	Trichoptera	Psychomyiidae	N/A																		
QT999999	Trichoptera	sp.	8																		
QT139999	Trichoptera	Tasimiidae	8																		
IF619999	Turbellaria	Dugesiidae	2																		
IF499999	Turbellaria	Temnocephalidae	5																		