Appendix 16

Assessment of Surface Water Environmental Values

BYERWEN COAL PROJECT

Assessment of Surface Water Environmental Values

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Limitations Statement

The sole purpose of this report and the associated services performed by Kellogg Brown & Root Pty Ltd (KBR) is to provide an assessment of the environmental values of surface water for the Byerwen Project in accordance with the scope of services set out in the contract between KBR and QCoal Pty Ltd ('the Client'). That scope of services was defined by the requests of the Client, by the time and budgetary constraints imposed by the Client, and by the availability of access to the site.

KBR derived the data in this report primarily from examination of records in the public domain and water quality monitoring data provided by the Client. The passage of time, manifestation of latent conditions or impacts of future events may require further exploration at the site and subsequent data analysis, and re-evaluation of the findings, observations and conclusions expressed in this report.

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Revision History

Revision	Date	Comment	Signatures		
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CONTENTS

Executive Summary

This report provides an assessment of the existing surface water environmental values with the potential to be impacted by the Byerwen Coal Project ('the Project'). The report provides technical information which will be input into the project Environmental Impact Statement (EIS). The report is written in the context of environmental values as defined by the Environmental Protection (Water) Policy 2009 (EPP (Water)).

The Project is located within the Rosella Creek and Upper Suttor River sub-catchments of the Bowen River catchment and Suttor River catchment respectively. These catchments constitute part of the headwaters of the Burdekin Basin. Two key watercourses have been identified within the study area. Kangaroo Creek drains the northern section of the proposed open cut operations, subsequently flowing into Rosella Creek, which drains into the Bowen River. The southern portion of the Project area is drained by the Suttor River which subsequently collects into the Burdekin Falls Dam downstream of its confluence with the Belyando River.

No environmental values are attributed by the EPP (Water) to the watercourses within the study area; therefore site-specific environmental values for the receiving water were derived from a review of land and downstream water uses within the relevant sub-catchments. This exercise was augmented by a review of a qualitative assessment of sub-catchment environmental values provided within the Burdekin Water Quality Improvement Plan Catchment Atlas (Dight, 2009).

The ecosystem condition that is most appropriate for affected waterways under the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC, 2000) (herein referred to as the ANZECC guidelines), is a 'slightly to moderately disturbed (SMD) system'. The appropriate water types are 'upland streams' and 'lowland streams', as defined by the Queensland Water Quality Guidelines (DEHP, 2009) (QWQG). The QWQG (Central Coast Queensland Regional Guideline Values for Physico-Chemical Indicators) were used as the default water quality guidelines for the Project area. A review of baseline water quality monitoring data for the study area revealed that for certain parameters such as pH, electrical conductivity and aluminium, background levels consistently exceeded the default guideline levels. Therefore, given that specific water quality objectives for the Burdekin Basin have not as yet been scheduled under the EPP (Water), a draft set of specific water quality objectives were derived specifically for the study area.

The draft water quality objectives will be used as the basis for developing mine water release criteria and a customised approach to management of water quality within the sub-catchment areas.

1 Introduction

1.1 PURPOSE

Kellogg Brown & Root Pty Ltd (KBR) has been commissioned by Byerwen Coal Pty Ltd (the proponent) to undertake an assessment of the existing environmental values of surface water resources which would potentially be affected by the Byerwen Coal Project ('the Project').

This report provides technical information which will be input into the project Environmental Impact Statement (EIS) and addresses the water quality component of the Terms of Reference for the project.

The report is written in the context of environmental values as defined by the Environmental Protection (Water) Policy 2009 (EPP (Water)). The report defines the environmental values of the study area and summarises the results of various water quality monitoring programs in order to present and define the baseline water quality for the study area. The report is also informed by the results of a site visit undertaken in September 2012.

The report then defines a draft set of Water Quality Objectives (WQO) necessary to protect the identified environmental values. These have been derived using site-specific data where possible. These WQO will subsequently be linked to the mine water management strategy to develop a water release plan and monitoring program for inclusion in the Environmental Management Plan. The monitoring program will assess the effectiveness of management strategies for protecting water quality during the construction, operation and decommissioning of the project.

Potential impacts on surface water quality are discussed in the Mine Water Management Strategy report, along with the release limits, water management infrastructure and other mitigation measures necessary to protect the surface water environmental values identified in this report.

Impacts on aquatic ecology are addressed within the Aquatic Ecology Impact Assessment Report prepared by AMEC Environment & Infrastructure Pty Ltd (AMEC).

1.2 REGULATORY FRAMEWORK

1.2.1 Water Act 2000

The Water Act 2000 provides the basis for the planning, allocation and use of Queensland water resources. Under the Act the provision of water for uses such as

irrigation, stock watering, drinking and industry must make allowances for the environmental requirements that support the ecological health of a water resource.

This Act provides criteria to determine if a drainage feature is considered to be a watercourse under the Act and therefore required to comply with specific criteria which regulate the interference with water or with a watercourse, including for example the diversion of a watercourse.

A watercourse as defined under the Act, must have certain characteristics of a channel of a river, creek or other stream between the outer banks laterally and between upstream and downstream limits longitudinally. It does not include a drainage feature and must have flow that persists after rain has ceased.

Officers of the Department of Environment and Heritage Protection (EHP) have inspected the waterways within the Project area and defined the extent of watercourses as per the Act (EHP letter of 19 July 2012). Further details of their advice are provided in Section 2.2 and 2.3.

1.2.2 Environmental Protection (Water) Policy 2009

The EPP (Water) seeks to protect and/or enhance the suitability of Queensland's waters for various beneficial uses. The policy identifies environmental values for waters within Queensland and guides water quality objectives to protect the environmental values of any water resource.

The Burdekin Basin catchment area and its tributaries are currently not included under Schedule 1 of this Policy, which lists the environmental values and water quality objectives for certain waterways waters within Queensland. As such, a generic set of environmental values for waters to be protected or enhanced have been adopted. It should be noted that environmental values and water quality objectives for this catchment are currently under review and are scheduled to be published by December 2013.

1.2.3 Water Resource (Burdekin Basin) Plan 2007

Under the Water Act 2000, water resource plans have been prepared for specific parts of Queensland in order to advance the sustainable management of water. The Water Resource (Burdekin Basin) Plan 2007 has the following purposes:

- to define the availability of water in the plan area
- to provide a framework for sustainably managing water and the taking of water
- to identify priorities and mechanisms for dealing with future water requirements
- to provide a framework for establishing water allocations
- to provide a framework for reversing, where practicable, degradation that has occurred in natural ecosystems
- to regulate the taking of overland flow water.

The plan applies to:

- water in a watercourse or lake
- water in springs
- overland flow water.

The Burdekin Resource Operations Plan 2009 (amended 2010) implements the provisions made by the Water Resource (Burdekin Basin) Plan 2007. This is achieved by the specification of rules and operational requirements for managing surface water resources in the basin.

1.2.4 Water Quality Guidelines and Assessment Tools

The ANZECC guidelines provide guideline values or descriptive statements for different indicators to protect aquatic ecosystems and human uses of water (e.g. primary recreation, human drinking water, agriculture, stock watering). These guidelines are a broad-scale assessment and it is recommended that, where applicable, locally relevant guidelines be adopted.

The Queensland Water Quality Guidelines (QWQG) (DERM, 2009a) are intended to address the need for locally relevant criteria identified in the ANZECC and Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ) Guidelines by:

- providing guideline values that are specific to Queensland regions and water types
- providing a process/framework for deriving and applying local guidelines for waters in Queensland (i.e. more specific guidelines than those in ANZECC and ARMCANZ).

2 Catchment description

2.1 CATCHMENT OVERVIEW

The Project is located across (straddles) the Suttor River and Bowen River catchments boundary, which are both part of the headwaters of the broader Burdekin River catchment (refer to Figures 2.1 to 2.3). The Burdekin catchment is the second largest in Queensland and covers an area of 133,432 km^2. Waterways within the Burdekin catchment vary between largely sandy, ephemeral creek systems to permanently flowing clear-water rivers and creeks that originate in mountain rainforest. The region is characterised by a dry tropical climate, which results in alternating extremes in river flows, from prolonged dry periods of no flow, to substantial flood events.

A review of Queensland Wetland Mapping data compiled by EHP indicated that there are no wetlands of international significance (Ramsar Convention) upstream of the Burdekin Falls Dam. The Burdekin Falls Dam is the largest dam in Queensland and is described in the Queensland Wetland mapping data as a lacustrine wetland. The water body is however an artificial and highly modified wetland. While recognised as a wetland by EHP, its ecosystem value is diminished because it is artificial and is operated for flood mitigation and irrigation/drinking water supply purposes. There are two weirs on the Burdekin River downstream of the Burdekin Falls Dam, the Blue Valley Weir and Clare Weir. The Burdekin River discharges to the Pacific Ocean near Ayr.

Within the Suttor 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 (part of the Suttor River catchment) to the south.

An overview of each sub-catchment in the Project area is provided below.

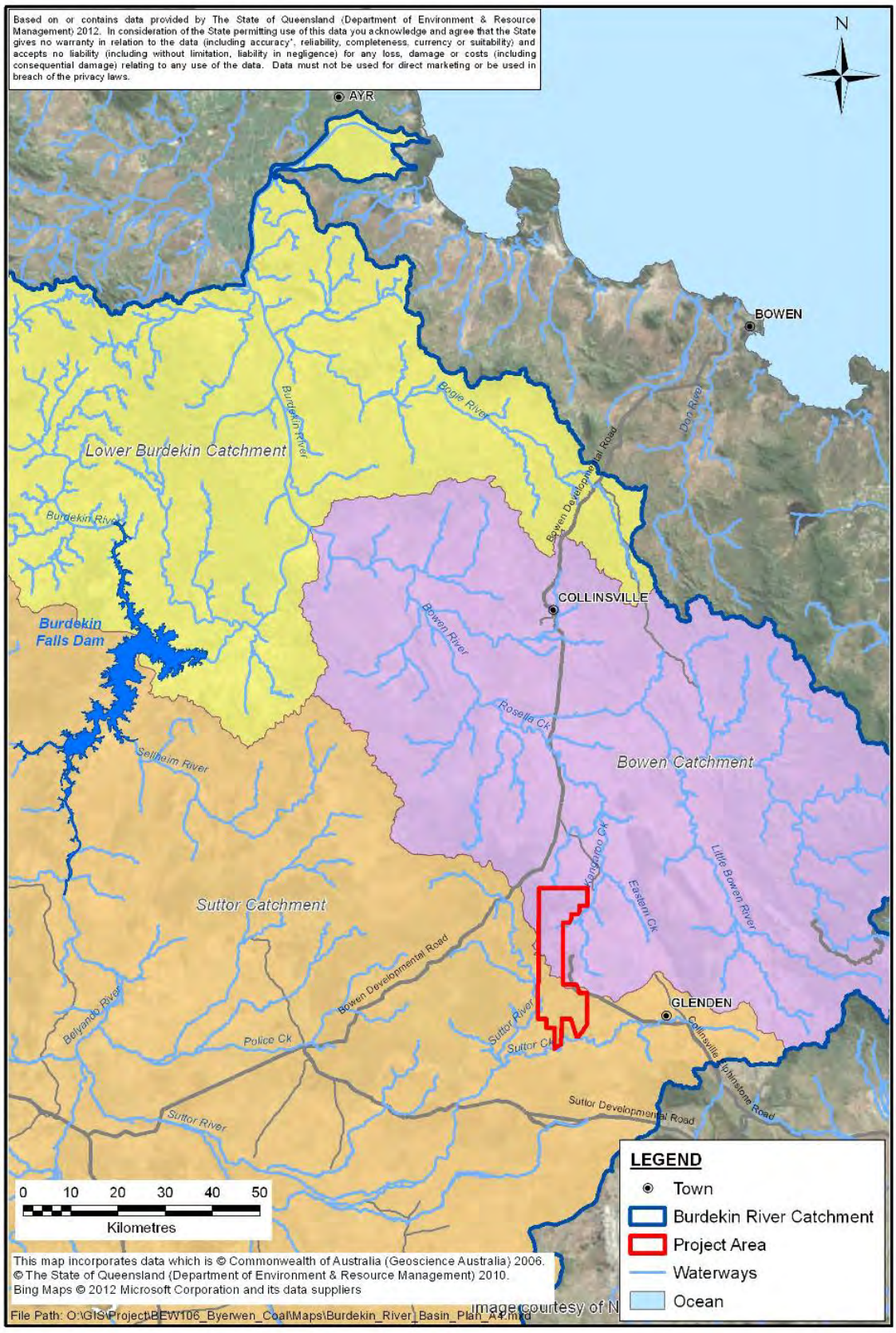

Figure 2.1
BURDEKIN BASIN CATCHMENTS

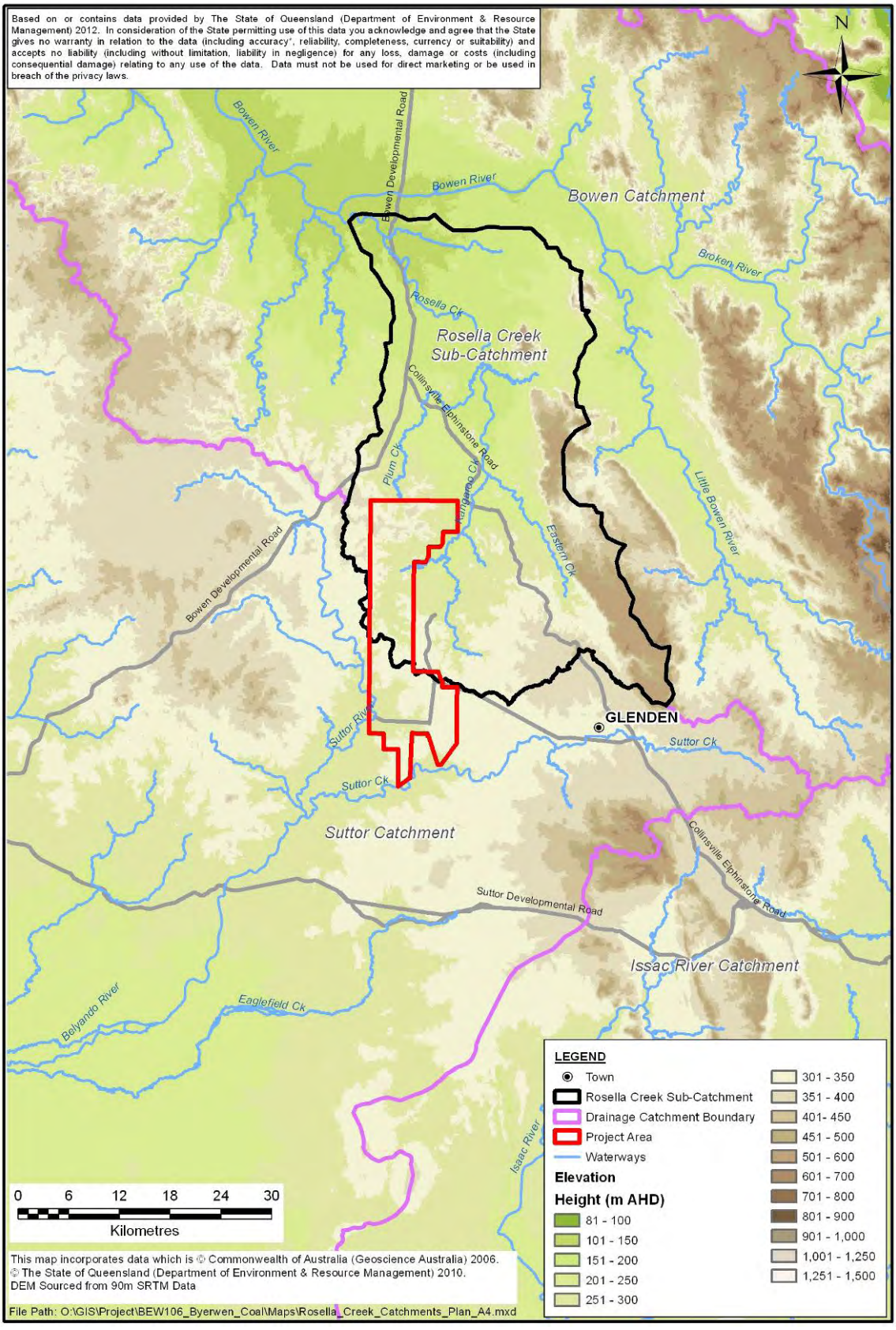

Figure 2.2
ROSELLA CREEK SUB-CATCHMENT

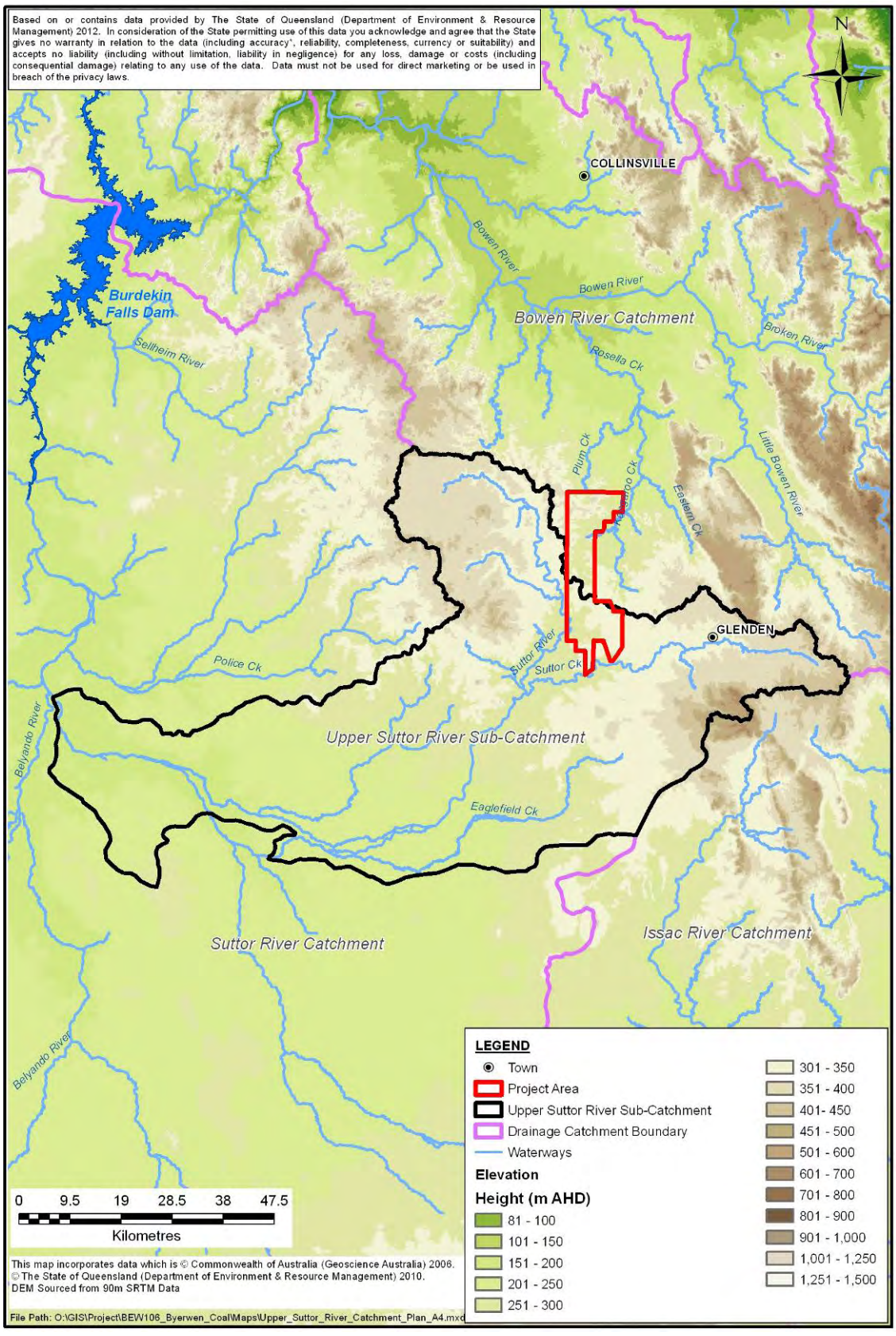

Figure 2.3
UPPER SUTTOR RIVER SUB-CATCHMENT

2.2 ROSELLA CREEK SUB-CATCHMENT

2.2.1 Sub-catchment description

The northern part of the Project area is located within the Rosella Creek sub-catchment of the Bowen catchment (refer to Figure 2.2). This sub-catchment covers an area of 1,473 km^2. The principal land use within the sub-catchment is grazing on native pastures. Approximately 20% of the land area is set aside for conservation and minimal use. Due to long-term grazing activities the condition of the waterways and riparian habitat in the sub-catchment has undergone major decline over the last 30 years due to extensive clearing of the floodplain (Burdekin Water Quality Improvement Plan 2009 [Dight, 2009]).

Hill slope erosion is identified by the Burdekin Water Quality Improvement Plan technical panel as the major source of sediment and particulate nutrients affecting water quality in the Rosella Creek sub-catchment, while gully and streambank erosion are also predicted to make substantial contributions. The rate of soil erosion is predicted to be moderate and below the overall Burdekin Basin average, while the total soil loss from the sub-catchment is comparatively low compared to other basin sub-catchments. Land condition is assessed as having the highest proportion in fair condition, with roughly equal proportions of good and poor condition.

Water quality in the Rosella Creek sub-catchment has been predicted by the Burdekin Water Quality Improvement Plan technical panel to be relatively poor, with elevated concentrations of sediment leaving the sub-catchment.

2.2.2 Drainage lines

The Project area encompasses ninety five riverine systems or drainage lines mapped by EHP within the Rosella Creek sub-catchment (AMEC, 2012). These include:

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

A letter of advice regarding watercourse determinations was provided to the proponent by EHP on 19 July 2012. Officers of EHP advised that within the Rosella Creek sub-catchment part of the Project area two watercourses met the characteristics of water courses under the Water Act 2000. These include Kangaroo Creek and a tributary of Kangaroo Creek (refer to Figure 2.4).

Kangaroo Creek is located in the upper reaches of the Rosella Creek sub-catchment and drains the northern section of the proposed open cut operations. Within the Project area, Kangaroo Creek consists of a largely sandy, ephemeral watercourse with sections of cobbles in the upper reaches. The bed and banks are generally sharply defined, as shown in Plates 2.1 to 2.3. Sections of the upper reaches accessed on 26 September 2012 consisted of a series of pools while closer to the north eastern edge of the Project area, recessional baseflows were encountered (refer to Plate 2.2). Locations of photographs are shown on Figure 2.4.

Kangaroo Creek becomes Rosella Creek downstream of the Project boundary, as shown in Figure 2.2. Rosella Creek itself is a largely sandy, dry seasonal creek system with limited habitat availability, although waterholes are present that create aquatic habitat in places (Dight, 2009). Prior to this EIS, the ecology and condition of aquatic habitats in the sub-catchment had not been studied in detail and as such the available historical information is somewhat limited (refer to Section 3.1.1 below). Further details regarding the existing aquatic ecology are presented within the Aquatic Ecology Impact Assessment Report (AMEC, 2012).

Rosella Creek flows generally north and discharges into the Bowen River and then the Burdekin River downstream of the Burdekin Falls Dam.

2.3 Upper Suttor River sub-catchment

2.3.1 Sub-catchment description

The southern part of the Project is situated in the 5,155 km^2 Upper Suttor River sub-catchment (refer to Figure 2.3). The overall Suttor Basin is approximately 18,153 km^2 and land use consists almost exclusively of grazing on natural and modified pastures. Other minimal land uses include dryland cropping of cereal. The riparian habitat of the sub-catchment has deteriorated over the last 30 years, principally due to clearing along headwater streams and on the floodplains, and is currently assessed to be in poor condition. As with the Rosella Creek sub-catchment, the ecology and condition of aquatic habitats has previously not been studied in detail and as such the available information is somewhat limited; however, the waterways are understood to include numerous in-channel and off-channel water bodies that are likely to be highly and persistently turbid (NQ Dry Tropics, 2009). Watercourses in the catchment are highly ephemeral.

Water quality in the Upper Suttor River sub-catchment is predicted to be moderately impacted by suspended sediment during wet season event flows, with elevated concentrations in the lower reaches of the sub-catchment.

Similar to the Rosella Creek sub-catchment, hillslope erosion is identified as the major source of sediment and particulate nutrients affecting water quality within the Suttor Basin, while gully erosion is also identified as a significant contributor. Water quality in the Suttor Basin is predicted by the Burdekin Water Quality Improvement Plan technical panel to have moderately elevated suspended sediment concentrations and loads at end-of-basin during wet season event flows (NQ Dry Tropics, 2009).

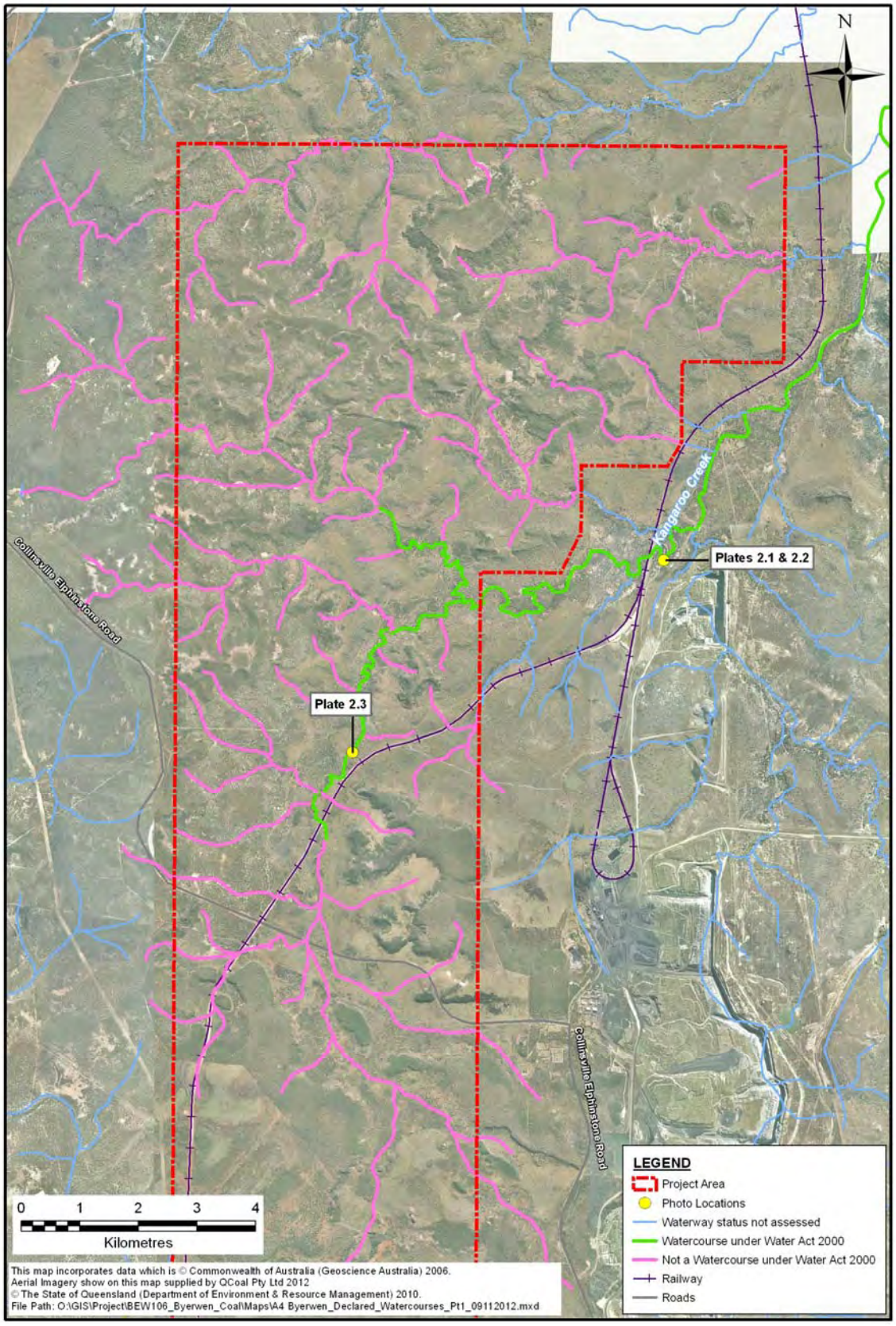

Figure 2.4
WATERCOURSES WITHIN THE NORTHERN PART OF THE PROJECT AREA

Plate 2.1: Kangaroo Creek looking upstream of Cerito Road crossing

Plate 2.2: Recessional baseflows in Kangaroo Creek looking downstream of Cerito Road crossing

Plate 2.3: Cobbled section in upper reaches of Kangaroo Creek looking upstream

2.3.2 Drainage lines

Within the Upper Suttor River sub-catchment, the Project area encompasses 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.

Within and immediately upstream and downstream of the Project area, the Suttor River consists of a large sandy, meandering watercourse. The river is ephemeral, with flow recorded at Eaglefield gauging station (approximately 25 km downstream of the Project area) less than 40% of the time. Recessional baseflows linking a series of pools were encountered during a site visit on 26 September 2012. The bed and banks of the river are sharply defined. Refer to Plates 2.4 to 2.5.

The Suttor River discharges into the Belyando River which ultimately drains to the Burdekin Falls Dam.

Plate 2.4: Suttor River at mining lease western boundary looking downstream

Plate 2.5: Suttor River at mining lease western boundary looking upstream

Officers of DEHP advised that a single tributary of the Suttor River within the project area meets the characteristics of a watercourse under the Water Act 2000. This ephemeral water course is labelled 'Tributary 1' on Figure 2.5 and flows from east to west across the southern section of the Project area. The watercourse was accessed at

two locations on 26 September 2012. As shown in Plates 2.6 to 2.9 the watercourse is ephemeral and generally sandy and the morphology of the channel ranges from sharply eroded and incised to gentle vegetated slopes. Isolated pools were observed.

The tributary of the Suttor River labelled as 'Tributary 2' on Figure 2.5 can be described as a dry, sandy, ephemeral drainage line. As shown on Plates 2.10 and 2.11 the banks and low flow channel are poorly defined. A lacustrine wetland (artificial) located along this drainage line is described within Section 3.1.2 and within the Aquatic Ecology Impact Assessment Report (AMEC, 2012).

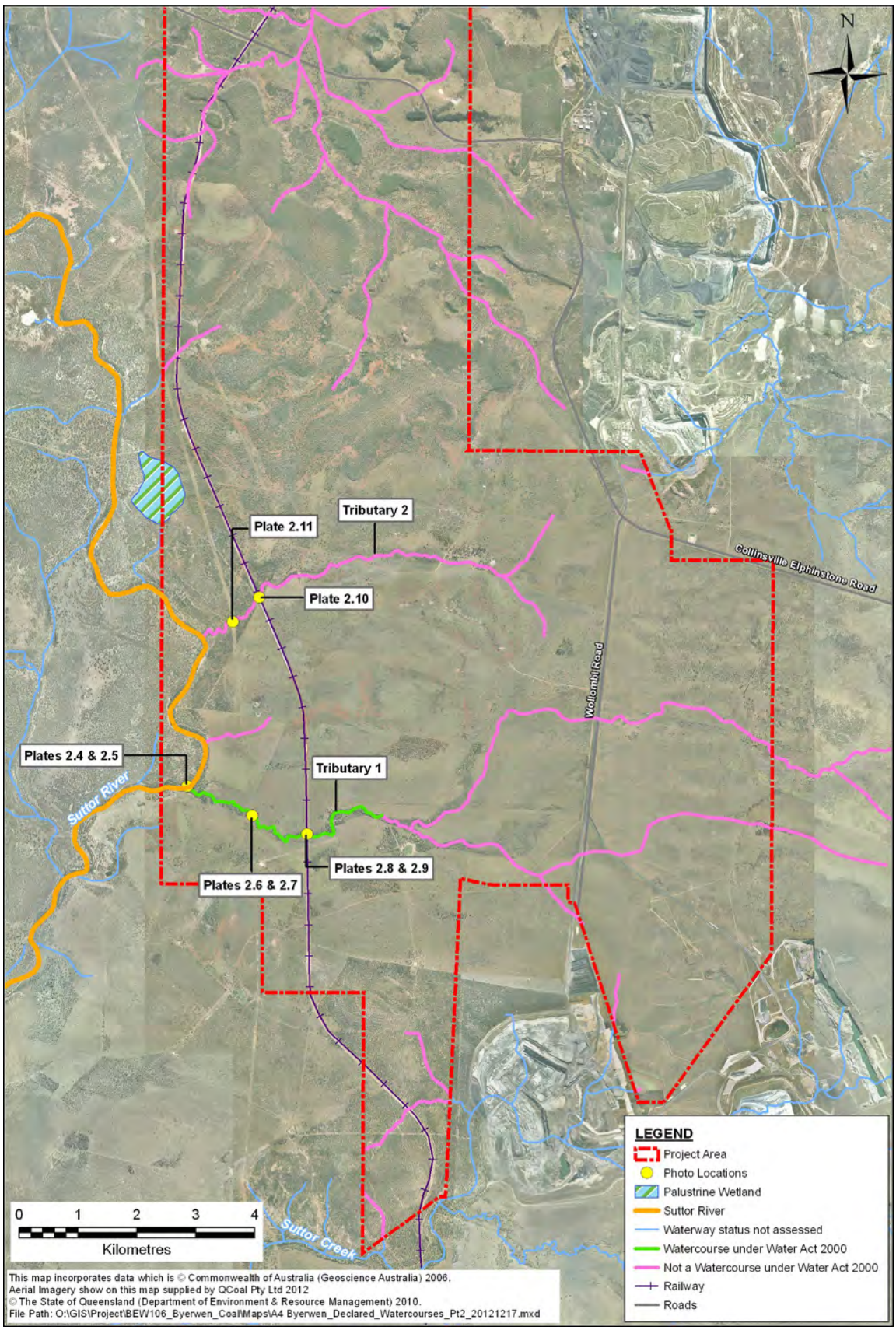

Figure 2.5
WATERCOURSES WITHIN THE SOUTHERN PART OF THE PROJECT AREA

Plate 2.6: Tributary 1 approximately 1 km from Suttor River looking downstream

Plate 2.7: Tributary 1 approximately 1 km from Suttor River looking upstream

Plate 2.8: Tributary 1 at Northern Missing Link railway line crossing looking downstream

Plate 2.9: Tributary 1 at Northern Missing Link railway line crossing looking upstream

Plate 2.10: Tributary 2 at Northern Missing Link railway line crossing looking upstream

Plate 2.11: Tributary 2 approximately 0.6 km upstream of Suttor River looking downstream

3 Environmental values and water quality objectives

3.1 ENVIRONMENTAL VALUES

Under the EPP (Water), the protection of the receiving environment is guided by the identification of environmental values that pertain to those waters. Environmental values are defined in DEHP (2010) as 'a quality or physical characteristic of the environment that is conducive to ecological health or public amenity or safety'. Environmental values require protection from the effects of pollution, waste discharge and modified sediment processes.

Currently there are no environmental values established for the Burdekin Basin Catchment, as per Schedule 1 of the EPP (Water) 2009. Environmental values adopted for the receiving waterways have therefore been identified based on a review of land uses and down stream water usage patterns within the relevant sub catchments. The Burdekin Water Quality Improvement Plan (2009) (BWQIP) presents a qualitative assessment the sub-catchments and this was also referenced. The environmental values for each of the two sub-catchments are listed within Table 3.1 and discussed below.

Table 3.1 Draft environmental values for the Burdekin Catchment

Rosella Creek Sub-catchment	Upper Suttor River Sub-catchment
• Aquatic ecosystems	• Aquatic ecosystems
• Stock watering	• Stock watering
• Industrial users	• Industrial users
• Cultural and spiritual	• Cultural and spiritual
	• Human consumption
	• Primary recreation
	• Secondary recreation
	• Visual recreation
	• Drinking water

3.1.1 Rosella Creek Sub-catchment – Draft environmental values

Aquatic ecosystems

As in the case of other drainage lines within the sub-catchment, Kangaroo and Rosella Creeks experience flow only after sustained or intense rainfall. Stream flows are highly variable with most channels drying out and aquatic fauna concentrating in senescing pools in the drier months. As a consequence, physical attributes, water

quality and the composition of aquatic floral and faunal communities are also expected to be highly variable over time.

The aquatic ecosystem values of the sub-catchment are considered to be slightly to moderately disturbed as a consequence of the surrounding land use for cattle grazing.

Stock watering

Land use in the area is dominated by grazing. Water supply for production of healthy livestock is commonly extracted from the surrounding water resources.

Industrial use

Mining has a presence within this catchment and further development is planned. Specifically, the Newlands Coal mine is located immediately to the east of the Project and that operation is likely to be extended within the life of the Project.

Cultural and spiritual

The Birriah and Jangga traditional owners have custodial use of water resources within the catchment.

3.1.2 Suttor River Sub-catchment – Draft environmental values

Aquatic ecosystems

The Suttor River and its tributaries are ephemeral streams which can occasionally contain large waterholes. The magnitude of these waterholes and the length of time for which they persist during dry conditions is dependent on the substrate composition and the season and climatic conditions at the time. As in the case of the Rosella Creek sub-catchment above, physical attributes, water quality and the composition of aquatic floral and faunal communities will be highly variable over time.

This area shows some pre-existing dry land salinity which is likely to result from erosion caused by a combination of both natural processes and anthropogenic land uses such as cattle grazing. This may cause a potential threat to aquatic ecosystems within the catchment. According to the Burdekin Water Quality Improvement Plan technical panel, macroinvertebrates have experienced moderate change along the whole Suttor River. Fish and water quality are moderately affected below the junction with the Belyando River.

As described in the Aquatic Ecology Impact Assessment report (AMEC, 2012) two lacustrine wetlands and a single palustrine wetland area are located within or immediately adjacent to the Project footprint (refer to AMEC, 2012 for further details regarding the ecological values of these wetlands). The lacustrine wetlands will be removed as part of the Project. It is understood that the palustrine wetland will be retained, and not physically disturbed by mining activities. Potential impacts on the hydrology and ecology of this wetland are addressed within the Mine Water Management Strategy and Aquatic Ecology Impact Assessment reports respectively.

The aquatic ecosystem values of the overall sub-catchment are considered to be slightly to moderately disturbed as a consequence of the surrounding land use for cattle grazing.

Stock watering

Land use is almost exclusively grazing on natural and modified pastures. Water supply for production of healthy livestock is commonly extracted from the surrounding water resources.

Primary, secondary and visual recreation

Swimming, fishing and camping have been identified activities along the Suttor River.

Industrial uses

Coal mining activities are undertaken within this catchment and further development is planned.

Cultural and spiritual values

Traditional owners are the Jangga and the Birriah people.

Environmental values include:

- water access and use
- water allocation for traditional owners
- water to camp near for traditional activities
- participation in the management of water.

Drinking water

Drinking water is cited as an environmental value in the BWQIP (2009). There are however no urban areas or towns located downstream of the Project area within the sub-catchment and the very small population is widely scattered on pastoral holdings. A review of aerial photography revealed two residences in proximity to the Upper Suttor River. The potential therefore exists for river water to be used for drinking purposes.

Irrigation

As stated above, the predominant agricultural land use within the sub-catchment is grazing. The nearest property with a license to take water for crop irrigation purposes is located approximately 60 km downstream of the Project area (refer to Figure 3.1).

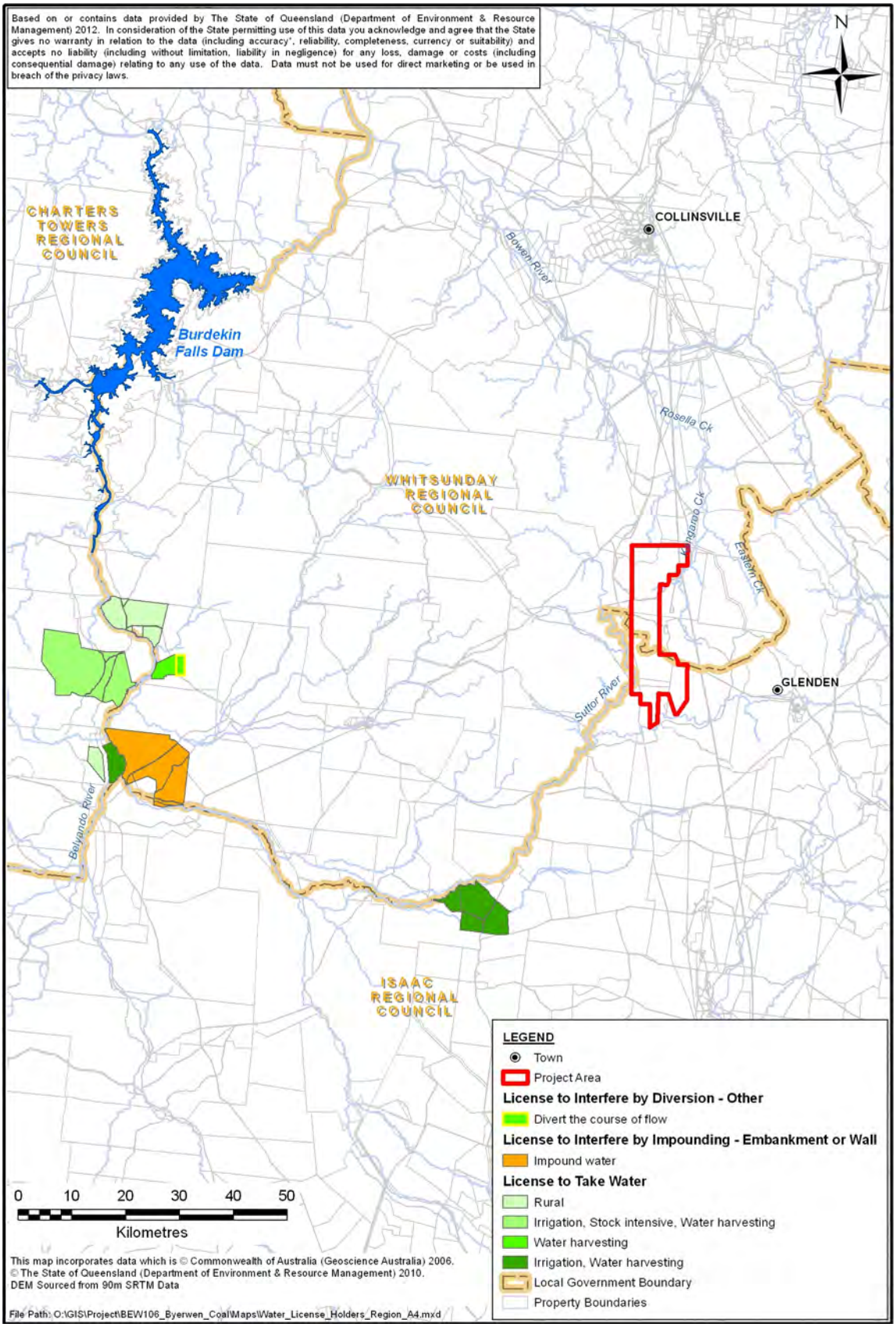

Figure 3.1
WATER LICENCE HOLDERS

3.2 CLASSIFICATION OF EXISTING AQUATIC ECOSYSTEMS

The ANZECC guidelines describe how aquatic ecosystems can be subdivided into three levels of protection based on their current condition. These levels of protection include the following:

- High Ecological Value (HEV) ecosystems – These are essentially unmodified, highly valued aquatic ecosystems in which the ecological integrity is regarded as intact.
- Slightly to Moderately Disturbed (SMD) ecosystems – These are aquatic ecosystems in which aquatic biodiversity may have been diminished to a small but measurable degree by human activity, but where the biological communities remain in a healthy condition.
- Highly Disturbed (HD) ecosystems – These are degraded aquatic ecosystems with reduced and/or highly modified ecological values due to human activity. These are degraded aquatic ecosystems with reduced and/or highly modified ecological values due to human activity.

The aquatic ecosystem values of the Rosella Creek and Upper Suttor River sub-catchments beyond the Project area are considered to be SMD.

3.3 DEFAULT WATER QUALITY GUIDELINES

Water quality guidelines are recommended numerical concentration levels or narrative statements that will support and maintain the designated environmental values of a particular water body. They form the basis for determining water quality objectives.

There are three main references used to identify guideline values in Queensland:

- ANZECC Guidelines – These guidelines provide guideline values (numbers) or descriptive statements for different indicators to protect aquatic ecosystems and human uses of waters (e.g. primary recreation, human drinking water, stock watering). For aquatic ecosystems, although the guidelines provide extensive default guideline values, they strongly emphasise the need to develop more locally relevant guidelines.
- QWQG – The QWQG are intended to address the need identified in the ANZECC guidelines by:
  - providing guideline values (numbers) that are tailored to Queensland regions and water types
  - providing a process/framework for deriving and applying more locally specific guidelines for waters in Queensland.
- EPP (Water) – Environmental values and water quality objectives (WQO) have been scheduled under the EPP Water for certain waters within Queensland.

The EPP (Water) describes the method for applying the most relevant water quality guidelines (e.g. national, state, local). It states that the most locally relevant guideline will be used in preference to broader guidelines. Therefore, where the QWQG provides water quality guideline values for Queensland waters, it will take precedence over the ANZECC guidelines. It should be noted that for indicators such as toxicants and other industrial and agricultural uses, ANZECC guidelines remain the principal source of information.

At the time of the assessment, no environmental values or water quality objectives have been scheduled under EPP (Water) for the Burdekin catchment. Therefore the Central Coast Queensland Regional Guideline Values for Physico-Chemical Indicators for SMD waters have been adopted as default values for both the Rosella Creek and Upper Suttor River sub-catchments (refer to Table 3.2). These guidelines revert to the ANZECC guidelines for certain water quality parameters.

Note that for freshwaters, the QWQG generally defaults to the ANZECC 2000 guidelines categories of upland and lowland freshwaters. The ANZECC Guidelines suggest a cutoff of 150 m elevation to differentiate between lowland and upland freshwaters. However, the QWQG also acknowledge that this definition is not applicable in all instances and also broadly defines upland freshwaters as small (first or second order) upland streams that are moderate to fast flowing due to steep gradients with substrates usually consisting of cobbles, gravel or sand. Lowland streams are defined by the QWQG as larger (>3rd order streams), slow flowing and meandering streams with very slight gradients and substrates which are rarely comprised of cobble and gravel but more often of sand, silt or mud.

While all watercourses in the study area are located at elevations of >150 m, the broader QWQG definitions of freshwaters were considered to be more applicable. As such, the Suttor River, Suttor Creek and the majority of Kangaroo Creek have been considered to be lowland freshwaters with default trigger values assigned accordingly. Tributaries of these watercourses and the upper reaches of Kangaroo Creek were considered to be upland freshwater streams.

Table 3.2 Default trigger values for catchments in the project area

Parameter	Units	Default Trigger Value Lowland*	Default Trigger Value Upland*
pH (flow)	pH Units	Lower – 6.5	Lower – 6.5
		Upper – 8.0	Upper – 7.5
pH (nil flow or flood event)	pH Units	Lower – 5.5	Lower – 5.5
		Upper – 9.0	Upper – 9.0
Conductivity (Upper Suttor)#	µS/cm	168	168
Conductivity (Rosella)#	µS/cm	271	271
Turbidity	NTU	50	25
Total Nitrogen	mg/L	0.5	0.25
Oxidised Nitrogen	mg/L	0.06	0.015
Total Phosphorus	mg/L	0.05	0.03
Sulfate (dissolved)	mg/L	250	250
Metals**			
Dissolved Aluminum	mg/L	0.055	0.055
Dissolved Boron	mg/L	0.37	0.37
Dissolved Copper	mg/L	0.0014	0.0014
Dissolved Manganese	mg/L	1.9	1.9
Dissolved Nickel	mg/L	0.011	0.011
Dissolved Zinc	mg/L	0.008	0.008

** Default Trigger Values derived from QWQG or ANZECC (2000)*
*** Metals trigger values based on 95th percentile protection levels*
 # Conductivity values derived using 75th percentile protection value for the specific sub-catchment (as presented in Appendix G of QWQG)

3.4 EXISTING WATER QUALITY

A range of water chemistry data has been analysed to describe the water quality characteristics of the respective catchments. This section summarises the water quality indicators of relevance for the Project. These have been used to establish a baseline assessment on which to base the management measures necessary to protect environmental values relevant discussed in Section 3.1 above.

3.4.1 Data source

Data was sourced from surface water monitoring events performed within the Rosella Creek and Upper Suttor River sub-catchments on and around the Byerwen project site by Newlands Coal between 2006 and 2011 and by the proponent from 2010 to 2012. Data was compiled and analysed by KBR in 2012.

Sample locations relevant to the Project were selected to describe the physical and chemical parameters of the potentially affected waterways. Table 3.3 identifies the sites used in the compilation and analysis of this data. Locations of monitoring sites are shown on Figure 3.2.

On the basis of a detailed review of the monitoring data, the dataset was considered to be adequate with sufficient spatial distribution along the lengths of relevant waterways as well as within tributaries located within the Project areas. The number of monitoring events for each parameters ranged widely (from 2 to 303) but generally sufficient to facilitate a robust assessment (>10). For 6 of the 21 sites, the monitoring period covered only one wet season and this was taken into account when utilising the data. Sufficient parameters were available to assess water quality against the appropriate QWQG and ANZECC guidelines with the exception of Total Phosphorus which was only represented in a small number of samples at a small number of monitoring sites.

Water hardness values varied across the Project area from ‘soft’ (0–59 mg/L) to ‘extremely hard’ (>240 mg/L). The Rosella Creek sub-catchment was characterised by ‘hard’ to ‘extremely hard’ water values, with the exception of two sites in the very upper reaches of Kangaroo Creek. The Upper Suttor River sub-catchment was generally characterised by ‘soft’ to ‘moderate’ water values. The exception to this were the four sites along Suttor Creek, for which hardness values ranged from ‘moderate’ to ‘extremely hard’.

During a site visit on 26 September 2012, a series of water quality field measurements were taken at various locations within and immediately adjacent to the Project area. Parameters tested included electrical conductivity, temperature, turbidity and pH. These field test results were considered in conjunction with the longer term water quality data set, as part of the overall analysis of existing water quality. In addition the results of field tests and a one-off water quality sampling event undertaken by AMEC during a site visit between 1 and 6 May 2012, were also considered.

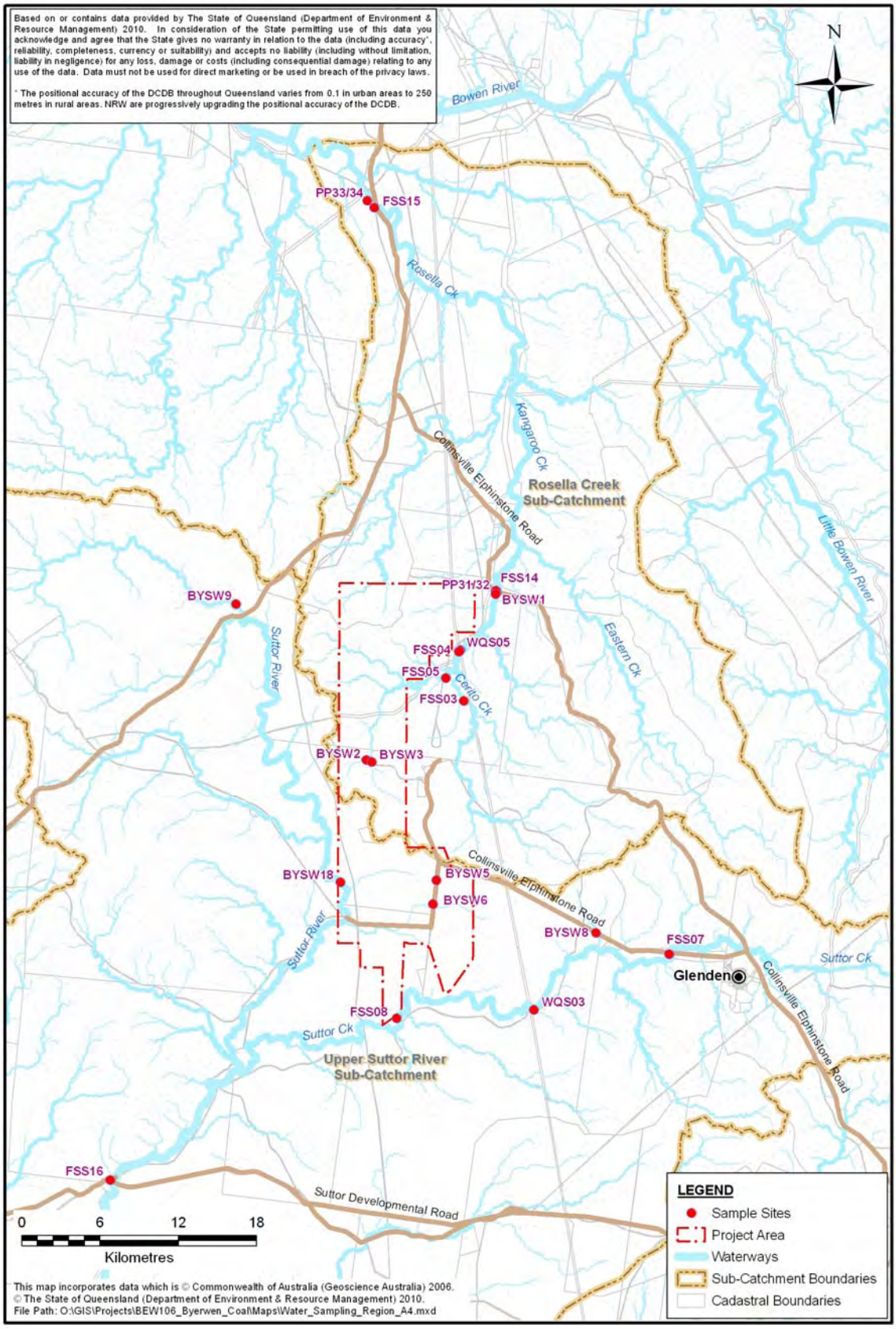

Figure 3.2
SURFACE WATER MONITORING LOCATIONS

Table 3.3 Summary of water quality monitoring sites

Data Source	Site	Sub-Catchment	Location	Period	Number of Observations
Byerwen surface water monitoring data – provided by Q Coal	BYSW1	Rosella	2 km south of Byerwen waterhole	Apr 2012	2
	BYSW2	Rosella	Gully south of rail line – central site	Dec 2010 – Apr 2012	15
	BYSW3	Rosella	Gully north of rail line – central site	Dec 2010 – May 2011	11
	BYSW5	Suttor	Along Suttor Creek transport corridor between Newlands and Suttor Creek	Dec 2010 – May 2011	9
	BYSW6	Suttor	2 km south of BYSW5 along same transport corridor	Dec 2010 – Apr 2012	14
	BYSW8	Suttor	10 km east of lease boundary along Collinsville–Elphinstone Road	Dec 2010 – Mar 2012	11
	BYSW9	Suttor	4 km south west of north western lease boundary	Mar 2012 – Apr 2012	5
	BYSW18	Suttor	Suttor River on western lease boundary	Mar 2012 – May 2012	2
Newlands Coal Project collated dataset – provided by Xstrata	PP 32	Rosella	1 km south of Byerwen waterhole	Jan 2010 – Apr 2011	6
	PP 33	Rosella	1.5 km south of Havilah pump hole	Jan 2007 – Apr 2011	10
	PP 34	Rosella	1 km south of Havilah pump hole	Jan 2008 – Apr 2011	7
	FSS 3	Rosella	2.5 km downstream of Cerito Creek junction	Dec 2007 – Sep 2011	46
	FSS04	Rosella	Kangaroo Creek downstream at water quality station	Dec 2006 – Oct 2011	211
	FSS05	Rosella	Kangaroo Creek upstream, 1 km west of junction	Feb 2007 – Sep 2011	84
	FSS07	Suttor	8 km east of Suttor Creek waterhole	Nov 2006 – Sep 2011	66
	FSS08	Suttor	Suttor Creek, southern most point of Byerwen lease area	Jun 2006 – Aug 2011	303
	FSS14	Rosella	1.5 km south of Byerwen waterhole	Dec 2010 – Sep 2011	149
	FSS15	Rosella	30 km north of Byerwen lease area	Dec 2010 – Sep 2011	173
	FSS16	Suttor	Suttor River at Suttor Developmental Road bridge 20 km south west of Byerwen lease area	Jan 2007 – Aug 2011	32
	WQS03	Suttor	Suttor Creek, east of Suttor Creek lease area	Nov 2010 – Jan 2011	7
	WQS05	Rosella	Kangaroo Creek downstream at water quality station	Feb 2010 – Oct 2010	21

3.4.2 Rosella Sub-catchment

A summary of the baseline water quality monitoring data for the Rosella sub-catchments (median values and 80th percentile) is presented within Tables 3.4 and 3.5. A summary of the full set of raw water quality monitoring data utilised for this assessment is contained within Appendix A. This summary presents the water quality monitoring data per sampling location in the context of minimum, maximum and median values as well as the 20^{th} and 80^{th} percentiles. A discussion of the key water quality indicators is provided below.

Table 3.4 Summary median water quality data for Rosella Creek sub-catchment

Parameter	Units	Default Trigger Level* (lowland/upland)	BYSW1	BYSW2^	BYSW3^	PP32	PP33	PP34	FSS03^	FSS04	FSS05	FSS14	FSS15	WQS05
pH(field)	pH units	6.5-8.0 / 7.5[#]	**8.6**	**8.2**	-	**8.2**	**8.4**	**8.5**	**8.2**	**8.3**	**8.3**	**8.3**	**8.3**	7.4
pH(lab)	pH units	6.5-8.0 / 7.5[#]	**8.4**	**7.7**	**7.8**	**8.4**	**8.3**	**8.4**	**8.2**	**8.4**	**8.4**	**8.4**	**8.4**	7.8
EC (field)	µS/cm	271	**1150**	**350**	-	**522**	**465**	**393**	**1079**	**1653**	**1133**	**2071**	**1750**	**286**
EC (lab)	µS/cm	271	**1285**	177	179	**431**	**622**	**509**	**1200**	**1755**	**1185**	**1960**	**1595**	256
Turbidity (lab)	NTU	50 / 25	35	**280**	**340**	**89**	**90**	**95**	**45**	23	7	36	27	-
Oxidised Nitrogen	mg/L	0.06 / 0.015	**0.285**	**0.020**	**0.020**	-	-	-	-	-	-	-	-	-
Total Nitrogen	mg/L	0.5/ 0.25	**0.80**	**1.00**	**0.80**	0.01	0.01	0.01	0.04	0.12	0.08	0.19	0.03	0.04
Total Phosphorus	mg/L	0.05/ 0.03	-	**0.35**	**0.13**	-	-	-	-	-	-	-	-	-
Sulfate (dissolved)	mg/L	250	38	5	9	26	30	16	171	233	18	242	155	10
Dissolved Metals														
Aluminium	mg/L	0.055	0.01	**0.38**	**0.45**	**0.070**	0.010	0.010	0.010	0.010	0.020	0.010	0.010	**0.090**
Boron	mg/L	0.37	0.08	0.07	0.05	0.06	0.07	0.06	0.06	0.07	0.06	0.08	0.08	0.05
Copper	mg/L	0.0014	**0.002**	**0.003**	**0.003**	0.0010	**0.0020**	**0.0020**	**0.0020**	0.0010	0.0010	0.0010	**0.0020**	**0.0020**
Manganese	mg/L	1.9	0.00	0.00	0.00				0.00	0.00	0.00	0.00	0.0	-
Nickel	mg/L	0.011	0.003	0.005	0.004	0.002	0.001	0.001	0.004	0.003	0.002	0.003	0.002	0.004
Zinc	mg/L	0.008	0.006	0.006	0.006	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005
Total Metals														
Aluminium	mg/L	n/a	1.73	4.50	1.30	0.350	0.260	0.420	1.450	0.510	0.105	0.720	0.730	36.000
Boron	mg/L	n/a	0.08	0.07	0.08	0.06	0.07	0.06	0.06	0.07	0.06	0.08	0.08	0.05
Copper	mg/L	n/a	0.0020	0.0070	0.0062	0.0030	0.0020	0.0020	0.0030	0.0020	0.0020	0.0020	0.0025	0.0530
Manganese	mg/L	n/a	0.05	0.03	0.01	-	-	-	0.3	0.0	0.01	0.0	0.1	-
Nickel	mg/L	n/a	0.006	0.010	0.009	0.003	0.002	0.001	0.009	0.008	0.003	0.007	0.005	0.118
Zinc	mg/L	n/a	0.008	0.008	0.006	0.005	0.005	0.005	0.010	0.005	0.005	0.006	0.011	0.112

Values in RED indicates an exceedance of default trigger value
** See section 3.3*
^ Upland stream
[#] During flow

Table 3.5 Summary 80th percentile water quality data for Rosella Creek sub-catchment

Parameter	Units	Default Trigger Level* (lowland/upland)	BYSW1	BYSW2^	BYSW3^	PP32	PP33	PP34	FSS03^	FSS04	FSS05	FSS14	FSS15	WQS05
pH(field)	pH units	6.5-8.0 / 7.5#	**8.6**	**8.4**	-	**8.4**	**8.6**	**8.7**	**8.5**	**8.4**	**8.4**	**8.5**	**8.5**	7.8
pH(lab)	pH units	6.5-8.0 / 7.5#	**8.4**	**8.0**	**7.9**	**8.4**	**8.5**	**8.7**	**8.4**	**8.5**	**8.5**	**8.5**	**8.5**	7.9
EC (field)	µS/cm	271	**1240**	**440**	-	**887**	**962**	**477**	**3730**	**2817**	**1217**	**2702**	**2207**	**286**
EC (lab)	µS/cm	271	**1354**	**284**	251	**745**	**735**	**657**	**3714**	**2886**	**1270**	**2626**	**2108**	**316**
Turbidity (lab)	NTU	50/ 25	35	**460**	**440**	**113**	**137**	**145**	**615**	**96**	40	**136**	**550**	-
Oxidised Nitrogen	mg/L	0.06/ 0.015	**0.342**	**0.030**	**0.078**	-	-	-	-	-	-	-	-	-
Total Nitrogen	mg/L	0.5 / 0.25	**0.98**	**1.36**	**1.00**	0.16	0.04	0.01	0.14	**0.56**	0.23	**0.72**	0.16	0.08
Total Phosphorus	mg/L	0.05 / 0.03	-	**0.35**	0.18	-	-	-	-	-	-	-	-	-
Sulfate (dissolved)	mg/L	250	40	8	10	57	43	31	**467**	**456**	23	**408**	232	30
Dissolved Metals														
Aluminium	mg/L	0.055	0.010	**0.974**	**0.788**	**0.098**	0.040	0.020	**0.090**	**0.106**	0.050	**0.076**	**0.072**	**0.220**
Boron	mg/L	0.37	0.08	0.08	0.08	0.06	0.10	0.10	0.12	0.10	0.08	0.10	0.09	0.05
Copper	mg/L	0.0014	**0.0018**	**0.0040**	**0.0042**	**0.0020**	**0.0020**	**0.0020**	**0.0020**	**0.0020**	**0.0030**	**0.0020**	**0.0020**	**0.0020**
Manganese	mg/L	1.9	0.00	0.01	0.00	-	-	-	0.00	0.01	0.01	0.01	0.00	-
Nickel	mg/L	0.011	0.004	0.008	0.005	0.002	0.001	0.001	0.006	0.006	0.004	0.005	0.003	0.004
Zinc	mg/L	0.008	0.006	**0.008**	0.006	0.005	**0.009**	0.005	**0.010**	0.005	0.005	0.005	0.005	0.005
Total Metals														
Aluminium	mg/L	n/a	1.74	6.68	1.30	11.240	1.692	2.670	9.200	5.174	3.020	4.720	15.920	92.300
Boron	mg/L	n/a	0.08	0.08	0.08	0.06	0.10	0.10	0.12	0.10	0.08	0.12	0.10	0.05
Copper	mg/L	n/a	0.002	0.008	0.006	0.0090	0.0032	0.0030	0.0088	0.0070	0.0060	0.0078	0.0182	0.1000
Manganese	mg/L	n/a	0.05	0.05	0.01	-	-	-	0.3	0.1	0.01	0.2	0.6	-
Nickel	mg/L	n/a	0.007	0.013	0.009	0.015	0.004	0.005	0.022	0.015	0.013	0.014	0.025	0.232
Zinc	mg/L	n/a	0.010	0.011	0.006	0.019	0.009	0.006	0.045	0.020	0.016	0.019	0.038	0.186

Values in RED indicates an exceedance of default trigger value
** See section 3.3*
^ Upland stream
 # During flow

Electrical conductivity

The electrical conductivity data collected at all sites covers the period between February 2006 and April 2012. The median electrical conductivity at each site recorded values as high as 2,071 µS/cm with the lowest median value 177 µS/cm. The 80th percentile values in some areas exceeded 3,000 µS/cm. These results indicate that contrary to the 75th percentile QWQG indication of relatively low conductivity (271 microsiemens per centimetre) in the broader Suttor-Belyando Rivers, the waterways in the Project area appear to have an existing, elevated salinity.

A large degree of variation was noted for the electrical conductivity during periods of heavy rainfall with large spikes and troughs in the summer months. The variation is most likely attributed to evaporative processes concentrating dissolved salts during low flow periods and the effect of dilution from large flows during high flow periods.

pH

The QWQG indicate that median pH should range between 6.5 and 7.5 in upland streams and between 6.5 and 8.0 in lowland streams during periods of flow. The results indicate that existing conditions in the study area for upland waterways consistently exceed this range, with typical pH values of between 8.0 and 8.5. This finding is consistent with the nature of the soils within the catchment. The results for the lowland streams also consistently exceed the guideline values, except for one site (WQS05) in the Rosella sub-catchment.

During flood events and periods of no flow QWQG range between 5.5 and 9.0 at those sites where observations regarding flow were undertaken, flow conditions were generally varied, as would be expected within the ephemeral water courses of the study area. Regardless of the flow conditions at the time, none of the median or 80th percentile pH values exceeded the QWQG values for flood events or periods of no flow.

Turbidity

The QWQG indicate that turbidity in upland rivers should be less than 25 NTU and for lowland streams less than 50 NTU. The monitoring results indicate that existing conditions in these waterways often exceed these values. Only two sites site (FSS05 and BYSW1) noted an 80th percentile value below the guidelines. Median values for turbidity of up to 340 NTU were recorded in the Rosella Creek sub-catchment.

Waterways in the region were noted to display typical ephemeral waterway characteristics with an assessment of seasonal variation showing increases in the range of turbidity concentrations during the wet months.

Rosella Creek sub-catchment is subject to hill slope erosion and waterway bank erosion that will contribute to elevated turbidity, particularly during high flow periods. This may be attributed to the surrounding land use and as a consequence of cattle grazing.

Sulfate

The QWQG state that Sulfate levels should not exceed 250 mg/L. The monitoring results indicate that existing levels in these waterways are generally low and do not generally exceed this value, with the exception of three sites. The three sites, FSS03, FSS04, and FSS14 have 80th percentile values around 440 mg/L, however the median value at each of those sites does not exceed the 250 mg/L guideline value.

Aluminium

The median values of dissolved aluminium reported four sites exceeding the ANZECC guideline value of 0.055 mg/L. The median values at these four sites ranged from 0.07 to 0.45 mg/L. For the purposes of this assessment the highly conservative assumption has been made that 100% of the dissolved aluminium is bio-available. 80th percentile dissolved aluminium increased the number of sites exceeding the trigger level to 8 of 12, with the highest reported value 0.97 mg/L. This means that while aluminium appears to be occurring at higher concentrations than the trigger levels, only approximately 1% of the total aluminium present in the water column is dissolved and therefore potentially bioavailable.

Boron

The median and 80th percentile values for dissolved boron were all below the trigger values, therefore providing at least a 95% protection level for the aquatic organisms. It is also worthwhile to note that the median and 80th percentile values for total boron were also low, recording only up to 0.12 mg/L.

Copper

The ANZECC guidelines indicate a 95th percentile protection limit of 0.0014 mg/L for dissolved copper. Both median and 80th percentile values for dissolved copper generally exceed these limits.

Manganese

The median and 80th percentile values for dissolved Manganese were below the trigger values, therefore providing 95% protection level for the aquatic organisms.

Nickel

The 80th percentile value for dissolved nickel ranged between 0.001 and 0.008 mg/L and was therefore well below the trigger value of 0.011 mg/L.

Zinc

The median values for dissolved zinc did not exceed the trigger value of 0.008 mg/L. The 80th percentile value exceeded the trigger value at three sites by a small margin.

Metals summary

The Rosella Creek sub-catchment is subject to hill slope erosion as well as gully and stream bank erosion. In catchments such as this, it is common for some metals to have naturally high background concentrations. While total metal values provide an

indication of the total concentration of a metal present in the water column, the majority of these are attached to sediment under the prevalent alkaline conditions and are therefore not bioavailable. Dissolved metals provide a more accurate representation of the bioavailable concentration of the element, and most accurately reflect the protection limits outlined by the ANZECC guidelines.

Dissolved (80^{th} percentile) aluminium concentrations within the catchment occur at higher levels than ANZECC guidelines trigger levels at most of the sample sites. Median copper concentrations identified in the catchment also exceed the guideline trigger levels, and to a lesser extent elevated zinc concentrations were also noted. The most likely reason for these high concentrations is attributed to the surrounding geology, where soils with naturally high aluminium, copper and zinc concentrations have been mobilised by erosion and entered the surface water column during flow events.

The median of all other dissolved metal concentrations are below the trigger levels for the protection of 95% of the aquatic species, or where applicable, below the limit of reporting.

It should be noted that the bioavailability of heavy metals is also affected by the hardness of water and therefore guideline trigger values for copper, nickel and zinc require a site specific correction for hardness. As discussed within Section 3.4.1 above, the Rosella Creek sub-catchment is generally characterised by 'hard' to 'extremely hard' water values. When trigger values were corrected upwards, according to site specific hardness (refer to Appendix A), the concentration of dissolved zinc was observed to be below the hardness corrected trigger values across the catchment. Copper was also consistently below the corrected trigger value, with the exception of two sites. The hardness corrected trigger values for the abovementioned metals for each site are presented within Appendix A, alongside the baseline monitoring data. Table 3.4 and 3.5 above present the uncorrected trigger values.

3.4.3 Upper Suttor River Sub-catchment

A summary of the baseline water quality monitoring data for the Upper Suttor River sub-catchments (median values and 80th percentile) is presented within Table 3.6 and 3.7. The full set of water quality monitoring data utilised for this assessment is contained within Appendix A. A discussion of the key water quality indicators for each sub-catchment is provided below.

Table 3.6 Summary median water quality data for Upper Suttor River sub-catchment

Parameter	Units	Default Trigger Level* (lowland/upland)	BYSW5^	BYSW6^	BYSW8^	BYSW9	BYSW18	FSS07	FSS08	FSS16	WQS 03
pH(field)	pH units	6.5-8.0 / 7.5[#]	-	**8.1**	**8.1**	**8.8**	**8.1**	**8.0**	**8.3**	7.6	8.0
pH(lab)	pH units	6.5-8.0 / 7.5[#]	**7.7**	**7.8**	**8.0**	7.2	7.5	**8.1**	**8.3**	8.00	**8.2**
EC (field)	µS/cm	168	-	100	**400**	**200**	95	**619**	**761**	**449**	152
EC (lab)	µS/cm	168	**206**	161	**335**	159	159	**551**	**882**	**684**	145
Turbidity (lab)	NTU	50 / 25	**80**	**45**	**55**	**266**	**584**	**87**	**70**	16	-
Oxidised Nitrogen	mg/L	0.06 / 0.015	**0.025**	0.010	0.010	**0.080**	0.05	-	-	-	-
Total Nitrogen	mg/L	0.5/ 0.25	**0.90**	**0.80**	**0.40**	**1.00**	**0.6**	0.15	0.26	0.09	0.01
Total Phosphorus	mg/L	0.05 / 0.03	**0.14**	**0.15**	**0.04**	-	-	-	-	-	
Sulfate (dissolved)	mg/L	250	2	2	5	5	4	5	52	18	4
Dissolved Metals											
Aluminium	mg/L	0.055	**0.100**	**0.195**	0.010	**0.350**	**0.72**	0.025	0.020	**0.070**	**0.230**
Boron	mg/L	0.37	0.05	0.05	0.06	0.06	0.05	0.10	0.09	0.06	0.05
Copper	mg/L	0.0014	**0.0020**	**0.0030**	**0.0020**	**0.0020**	0.001	**0.0020**	**0.0020**	0.0010	**0.0020**
Manganese	mg/L	1.9	0.00	0.00	0.01	0.08	0.055	-	0.0	0.0	-
Nickel	mg/L	0.011	0.006	0.006	0.002	0.001	0.002	0.001	0.002	0.002	0.001
Zinc	mg/L	0.008	0.005	**0.009**	0.005	**0.012**	0.006	0.005	0.005	0.005	0.005
Total Metals											
Aluminium	mg/L	n/a	1.90	0.79	0.83	9.51	8.93	0.695	1.890	1.660	2.980
Boron	mg/L	n/a	0.05	0.05	0.06	0.06	0.05	0.10	0.09	0.06	0.05
Copper	mg/L	n/a	0.007	0.003	0.002	0.001	0.004	0.0030	0.0040	0.0020	0.0080
Manganese	mg/L	n/a	0.14	0.02	0.04	0.14	0.160	-	0.1	0.3	-
Nickel	mg/L	n/a	0.014	0.008	0.003	0.003	0.005	0.003	0.005	0.003	0.007
Zinc	mg/L	n/a	0.009	0.015	0.006	0.006	0.014	0.009	0.006	0.007	0.011

Values in RED indicates an exceedance of default trigger value
** See section 3.3*
^ Upland stream
[#] During flow

Table 3.7 Summary 80th percentile water quality data for Upper Suttor River sub-catchment

Parameter	Units	Default Trigger Level* (lowland/upland)	BYSW5^	BYSW6^	BYSW8^	BYSW9	BYSW18	FSS07	FSS08	FSS16	WQS 03
pH(field)	pH units	6.5-8.0 / 7.5#	-	**8.2**	**8.2**	**8.6**	**8.2**	**8.3**	**8.6**	8.0	8.0
pH(lab)	pH units	6.5-8.0/ 7.5#	**7.9**	**8.0**	**8.1**	7.5	7.5	**8.2**	**8.6**	**8.1**	**8.3**
EC (field)	µS/cm	168	-	**420**	**460**	**200**	98	**1561**	**1462**	**857**	155
EC (lab)	µS/cm	168	**237**	**218**	**741**	**218**	**183**	**2040**	**1558**	**884**	149
Turbidity (lab)	NTU	50 / 25	**178**	**107**	**140**	**305**	**606**	**151**	**203**	**198**	
Oxidised Nitrogen	mg/L	0.06 / 0.015	**0.054**	**0.020**	**0.020**	**0.082**	0.05	-	-	-	-
Total Nitrogen	mg/L	0.5 / 0.25	**1.20**	**1.16**	**0.60**	**1.30**	**0.64**	0.28	**0.68**	0.16	0.03
Total Phosphorus	mg/L	0.05 / 0.03	0.14	0.15	0.04	0.00	-	-	-	-	-
Sulfate (dissolved)	mg/L	250	13	6	23	5	4	9	99	38	5
Dissolved Metals											
Aluminium	mg/L	0.055	**0.262**	**0.332**	**0.200**	**0.806**	**1.004**	**0.250**	**0.160**	**0.530**	**0.268**
Boron	mg/L	0.37	0.05	0.05	0.10	0.06	0.05	0.10	0.11	0.07	0.05
Copper	mg/L	0.0014	**0.0034**	**0.0030**	**0.0020**	**0.0020**	0.001	**0.0028**	**0.0030**	**0.0020**	**0.0020**
Manganese	mg/L	1.9	0.02	0.01	0.02	0.16	0.075	-	0.0	0.4	-
Nickel	mg/L	0.011	0.007	0.006	0.002	0.002	0.002	0.002	0.002	0.002	0.003
Zinc	mg/L	0.008	0.007	**0.013**	0.006	**0.012**	0.006	0.007	0.005	0.007	0.005
Total Metals											
Aluminium	mg/L	n/a	1.90	1.65	0.92	9.700	9.510	5.140	5.502	5.890	71.240
Boron	mg/L	n/a	0.05	0.05	0.06	0.06	0.05	0.10	0.12	0.08	0.07
Copper	mg/L	n/a	0.007	0.004	0.002	0.003	0.0046	0.0108	0.0080	0.0070	0.0690
Manganese	mg/L	n/a	0.14	0.04	0.04	0.20	0.202	-	0.2	0.5	-
Nickel	mg/L	n/a	0.014	0.008	0.003	0.003	0.005	0.008	0.011	0.008	0.192
Zinc	mg/L	n/a	0.009	0.023	0.007	0.007	0.016	0.025	0.021	0.020	0.149

Values in RED indicates an exceedance of default trigger value
** See section 3.3*
^ Upland stream
 # During flow

Electrical conductivity

The data in this sub-catchment was collected from June 2006 to May 2012. The 75th percentile QWQG specifies a trigger level of 168 µS/cm, which is lower than in the adjoining Rosella Creek sub-catchment. The median recorded electrical conductivity values at most sites exceeded this criteria however large ranges were recorded in those median values with lower values in the region of 100 µS/cm while higher median values were in excess of 800 µS/cm. These results suggest the waterways in the Project area have an existing, elevated salinity. 80th percentile values exceeded the guideline value at all sites except one (WQS03).

pH

The QWQG indicate that during period of flow, median pH should range between 6.5 and 7.5 in upland rivers and between 6.5 and 8.0 in lowland rivers. The results from the Upper Suttor River sub-catchment study area indicate that the pH levels currently consistently exceed this range, with typically pH values between 8.0 and 8.5 pH units at most sites. This finding is consistent with the nature of the soils within the region.

The QWQG state that pH values during flood events and periods of no flow should range between 5.5 and 9.0 as for the Rosella Creek sub-catchment above, at those sites where observations regarding flow were undertaken, flow conditions were generally varied. Regardless of the flow conditions at the time, none of the median or 80th percentile pH values exceeded the QWQG values for flood events or periods of no flow.

Sulfate

Median and 80th percentile values for sulphate were below the guideline value of 400 mg/L across all sites.

Turbidity

Median values for turbidity in the study area of the Upper Suttor River sub-catchment were in the range of 20–580 NTU. The QWQG state that turbidity in upland rivers should not exceed 25 NTU and lowland rivers should not exceed 50 NTU. The monitoring data consistently exceeded these values.

Aluminium

The median values recorded for dissolved aluminium at each site in the Upper Suttor River sub-catchment was between 0.01 and 0.72 mg/L. The default trigger level derived from the ANZECC guidelines for dissolved aluminium is a value of 0.055 mg/L. As previously stated, 100% of dissolved aluminium is conservatively assumed as being bio-available. Therefore even with a low percentage of the total aluminium being described as bio-available (dissolved), the concentrations were still well in excess of the default trigger value in most cases. The 80th percentile dissolved aluminium results were in excess of the default trigger value at all sites.

Boron

The median and 80th percentile values for dissolved boron were below the trigger values, therefore providing at least a 95% protection level for the aquatic organisms.

Copper

Median values for dissolved copper ranged from 0.0015 to 0.003 mg/L. The trigger value of for Copper is 0.0014 mg/L. The 80^{th} percentile values exceeded the guidelines at all sites except for BYSW18.

Manganese

The median and 80th percentile values for dissolved manganese were below the trigger values, therefore providing 95% protection level for the aquatic organisms.

Nickel

The default trigger value for dissolved nickel is 0.011 mg/L. The median and 80th percentile for dissolved nickel is below the default trigger value at around 0.002 mg/L thereby providing 95% protection of the aquatic organisms.

Zinc

The ANZECC guideline trigger value for dissolved zinc is 0.008 mg/L. The median and the 80th percentile concentration for dissolved zinc are generally below the default trigger value across most sites, with four sites recording values slightly above the trigger value.

Metals summary

The Upper Suttor River sub-catchment contains naturally high background aluminium concentrations. Background Copper concentrations were also found to be above the recommended trigger levels, and to a lesser extent elevated background zinc concentrations were also noted. The soils and geochemistry of the rocks in the sub-catchment are the most likely source of these high metal concentrations as the elements become mobilised by erosion and enter the surface water column during flow events.

As discussed within Section 3.4.1 above, the Upper Suttor River sub-catchment is generally characterised by ‘soft’ to ‘moderate’ water values, with the exception of Suttor Creek where water hardness values varied from ‘moderate’ to ‘extremely hard’. When a hardness correction factor was applied to increase the guideline trigger values for copper, zinc and nickel, the concentration of dissolved zinc and copper generally exceeded the corrected guideline values, specifically at the ‘soft’ water sites along the Suttor River. The hardness corrected trigger values for the abovementioned metals for each site are presented within Appendix A, alongside the baseline monitoring data. Table 3.6 and 3.7 above present the uncorrected trigger values.

3.5 WATER QUALITY OBJECTIVES

Water quality objectives are numerical concentration levels or narrative statements of indicators established used for the long term management of receiving waters

(DERM 2009a). WQO use are based on the most relevant water quality guidelines but are derived for specific water types based on long term monitoring of unimpacted 'reference' sites.

While regional WQOs have been developed for Queensland, site-specific WQOs are preferred where sufficient information is available. Specific WQO for the protection of aquatic ecosystems within the Burdekin Basin are not included within Schedule 1 of the EPP (Water). Additionally, the BWQIP states that insufficient data is available from the Burdekin Dry Tropics NRM region to derive locally relevant WQO for freshwater ecosystems. Consequently site specific draft WQO have been derived based on the QWQG and ANZECC guidelines discussed within Section 3.2 above. This section discusses the derivation of WQOs for the study area.

3.5.1 Framework for establishing site-specific water quality objectives

As highlighted in the QWQG, WQOs for a particular receiving environment can be derived directly from the identified environmental values in which the WQO are set to protect.

As discussed within Section 3.4 and shown in Tables 3.4 to 3.7, at many of the baseline water quality sampling locations, some of the ambient surface water quality indicators exceed those stipulated in the relevant water quality guidelines. As the water quality guidelines cannot be appropriately applied in this instance, the derivation of a more appropriate set of WQO is required using guiding principles highlighted in the QWQG.

WQO for physical and chemical indicators have been set for the receiving environment of the Project using the following key steps:

1. selecting suitable baseline reference sites
2. defining the water type at the receiving environment
3. calculating guideline values based on reference data sets.

This approach is consistent with the recommended approach in the QWQG. Further detail on each of these steps is included in the following sections.

Selecting suitable reference sites

Reference sites or baseline sites are sites that are subject to little disturbance and reflect as close as possible to the natural conditions in the area. The QWQG suggest the following criteria should be used to select appropriate reference sites:

1. minimal disturbance locally and upstream of the site
2. no significant point discharge sources nearby
3. sufficient data is available.

Calculating guideline values

Guideline values (or WQO) can be derived from the dataset obtained from the reference sites. The recommended approach for the slightly to moderately disturbed receiving environment is to base the guideline values on the 20^{th} and 80^{th} percentiles

of the dataset (QWQG). The dataset needs to contain more than 12 data points with 24 data points considered more appropriate. The process for determining guideline values from reference sites is presented in Figure 3.2.

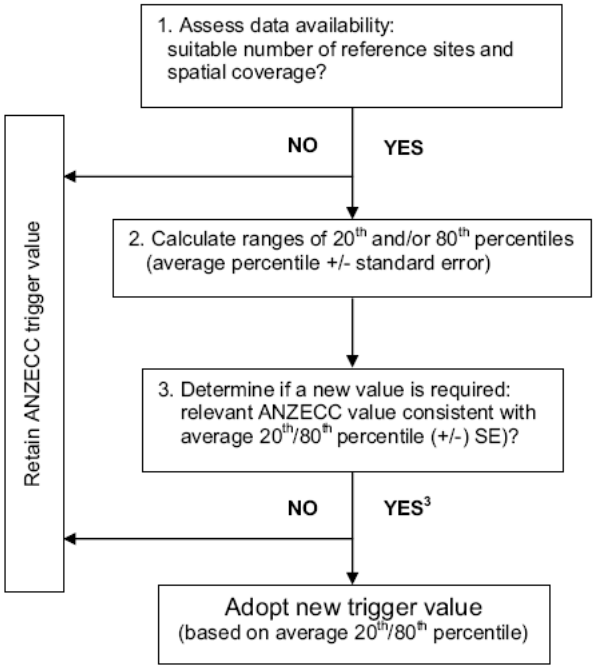

Figure 3.3
PROCEDURE FOR DETERMINING GUIDELINE VALUES FROM REFERENCE DATA

Source: DERM (2009a) Figure A.1

3.5.2 Rosella Creek sub-catchment

Water quality monitoring sites FSS05, BYSW2 and BYSW3 were considered as potentially suitable for reference sites. The catchment upstream of these locations is not pristine with land uses including grazing on native pastures. The catchment is also traversed by a railway and state controlled road. Potential impacts on water quality include clearing for agricultural purposes as well as previous mining exploration activities. However, the sites are located upstream of any discharge locations of the existing Newlands mine and are considered to be representative of the natural conditions of the area. Of the three sites, the most comprehensive dataset is available for FSS05 with 84 sampling events undertaken over the full spectrum of seasons between February 2007 and September 2011. It was therefore considered that this sampling location is most suitable to act as a reference site. Note that site FSS04 (211 sampling events) was not considered as a reference site on the basis that it is located downstream of discharge points of the Newlands mine.

While sampling locations BYSW2 and BYSW3 were considered suitable from a location point of view, the available dataset for these sites was smaller (15 and 11 sample events respectively) and therefore FSS05 was chosen as the key reference location in favour of these sites.

Table 3.8 presents a comparison between the default trigger values and the 80th percentile for ambient surface water quality. Where the 80th percentile values exceeded trigger values, the 80th percentile values have been adopted as the draft water quality objectives. Where there was considered to be insufficient data for a particular parameter at FSS05, data from BYSW2 were used instead.

Water at FSS05 was classified as 'hard', which is typical of the catchment. Guideline trigger values for copper, zinc and nickel were therefore corrected for this level of hardness.

Table 3.8 Comparison between guideline values and ambient surface water for site FSS05

Parameter	Units	Default Trigger Level	Reference Site				Draft WQO
			20th %ile	Median	80th %ile	n	Rosella Creek Sub-Catchment
pH(field)	pH units	6.5 – 8.0**	**8.1**	**8.2**	**8.4**	84	6.5 – 8.5**
pH(lab)	pH units		**8.1**	**8.4**	**8.5**	35	
EC (field)	µS/cm	271	**710**	**1133**	**1217**	84	1270
EC (lab)	µS/cm		**181**	**1185**	**1270**	34	
Turbidity (lab)	NTU	50	2	7	40	56	50
Oxidised Nitrogen	mg/L	0.06	0.02	0.02	0.03	11#	0.06
Total Nitrogen	mg/L	0.5	0.01	0.08	0.23	31	0.5
Total Phosphorus	mg/L	0.05	-	-	-	0	0.05
Sulfate (dissolved)	mg/L	250	4	18	23	35	250
Dissolved Metals							
Aluminium	mg/L	0.055	0.010	0.020	0.050	31	0.055
Boron	mg/L	0.37	0.05	0.06	0.08	32	0.37
Copper	mg/L	0.007~	0.0010	0.0010	0.0030	33	0.007
Manganese	mg/L	1.9	0.00	0.00	0.01	16	1.9
Nickel	mg/L	0.06~	0.001	0.002	0.004	33	0.06
Zinc	mg/L	0.04~	0.005	0.005	0.005	32	0.04

Values in RED indicates an exceedance of default trigger value
** See section 3.3*
*** During flow*
^ Insufficient data
 # Sourced from BYSW2
~ Hardness modified trigger value

3.5.3 Upper Suttor River sub-catchment

Water quality monitoring sites BYSW6, BYSW8 and FSS07 were considered as suitable reference sites. All three sites are located within local catchments that are not affected by discharge from existing mining operations but which exhibit minor disturbance from vegetation clearing for grazing purposes, a state controlled road, a coal haul road and mining exploration activities. Additionally, their location within catchments local to the proposed project means that water quality is representative of the local area and not affected by Suttor River catchment wide influences. The sites are therefore considered to be appropriately representative of the natural conditions of the area. Of the three sites, the most comprehensive water quality monitoring dataset

was available for FSS07 with 66 records spanning the period from November 2006 to September 2011. This site was therefore chosen as the prime reference site.

Table 3.9 presents a comparison between the default trigger values and the 80th percentile for ambient surface water quality. Where the 80th percentile value exceed trigger values, the 80th percentile values have been adopted as the draft water quality objectives. Where there was considered to be insufficient data for FSS07, data from BYSW6 was used instead (refer to footnote of Table 3.9).

The hardness value of water at FSS07 was classified as 'moderate', which is typical of the catchment. Guideline trigger values for copper, zinc and nickel were therefore corrected for this level of hardness.

Table 3.9 Comparison between guideline values and ambient surface water for site FSS07

Parameter	Units	Default Trigger Level*	Reference Site				DRAFT WQO
			20th %ile	Median	80th %ile	n	Upper Suttor River Sub-Catchment
pH(field)	pH units	6.5–8.0**	7.8	**8.0**	**8.3**	66	6.5–8.3**
pH(lab)	pH units		7.8	**8.0**	**8.2**	62	
EC (field)	µS/cm	168	**248**	**619**	**1561**	66	2040
EC (lab)	µS/cm		**267**	**551**	**2040**	62	
Turbidity (lab)	NTU	50	17	**87**	**151**	16	151
Oxidised Nitrogen	mg/L	0.06	0.01	0.01	0.02	13$^{\#}$	0.06
Total Nitrogen	mg/L	0.5	**0.64**	**0.8**	**1.16**	13$^{\#}$	1.16
Total Phosphorus	mg/L	0.05	-	-	-	^	0.05
Sulfate (dissolved)	mg/L	250	2	5	9	58	250
Dissolved Metals							
Aluminium	mg/L	0.055	0.010	0.025	**0.250**	56	0.250
Boron	mg/L	0.37	0.05	0.05	0.05	14$^{\#}$	0.37
Copper	mg/L	0.003$^{\sim}$	0.0010	0.0020	0.0028	57	0.003
Manganese	mg/L	1.9	0.001	0.003	0.007	14$^{\#}$	1.9
Nickel	mg/L	0.03$^{\sim}$	0.001	0.001	0.002	57	0.03
Zinc	mg/L	0.02$^{\sim}$	0.005	0.005	0.007	57	0.02

Values in RED indicates an exceedance of default trigger value
** See section 3.3*
*** During flow*
^ Insufficient data
$^{\#}$ Sourced from BYSW6
$^{\sim}$ Hardness modified trigger value

4 Conclusions and recommendations

This report has identified the environmental values to be protected within the Rosella Creek and Upper Suttor River sub-catchments. Based on these environmental values and the recommended water quality guidelines, a set of water quality objectives for the Project have been derived. These have been based on a review of baseline water quality monitoring data from which appropriate reference sites have been identified. The draft set of WQO for the site are presented in Table 4.1.

For the majority of parameters, the WQO values have been retained as the draft water quality objectives. The exceptions to this are pH, electrical conductivity, turbidity, total nitrogen, aluminium, copper and zinc. After reviewing the full set of baseline water quality data, as well as literature provided in the BWQIP, these parameters are high across both sub-catchments and therefore the upward revision of the guidelines is considered appropriate to be used as the basis for future management of water quality for the Project.

The draft water quality objectives below will be used as the basis for developing mine water release criteria and a customised approach to management of water quality within the sub-catchment areas. The Mine Water Management Strategy report will identify the potential impacting processes on water quality and the management measures necessary to protect the water quality and therefore environmental values of the study area. Specifically this report will stipulate the release limits (values that cannot be exceeded) applicable for the Project including those for pH and electrical conductivity.

Trigger investigation levels will also be identified and stipulated for downstream compliance points. Trigger investigation values are values that if exceeded, trigger further investigation and reporting processes. This normally includes comparing upstream and downstream water quality data and assessing the risk of causing environmental harm. Where it is not possible to assess upstream water quality data, a comparison to baseline data or an analogue catchment is undertaken. Finally, the mine water management report will identify a water quality monitoring program for release and downstream points in order to protect the environmental values and meet the water quality objectives identified in this report.

Table 4.1 Draft water quality objectives

Parameter	Units	Default Trigger Level*		Draft WQO	
				Upper Suttor River Sub-Catchment	Rosella Creek Sub-Catchment
pH (flow)	pH units	Upper	8.0	8.3	8.5
	pH units	Lower	6.5	6.5	6.5
pH (nil flow or flood event)	pH units	Upper	9.0	9.0	9.0
	pH units	Lower	5.5	5.5	5.5
Electrical Conductivity	µS/cm		168/271*	2040	1270
Turbidity (lab)	NTU		50	151	50
Oxidised Nitrogen	mg/L		0.06	0.06	0.06
Total Nitrogen	mg/L		0.5	1.16	0.5
Total Phosphorus	mg/L		0.05	0.05	0.05
Dissolved Sulfate	mg/L		250	250	250
Dissolved Aluminium	mg/L		0.055	0.250	0.055
Dissolved Boron	mg/L		0.37	0.37	0.37
Dissolved Copper	mg/L		0.003^/0.007#	0.003	0.007
Dissolved Manganese	mg/L		1.9	1.9	1.9
Dissolved Nickel	mg/L		0.03^/0.06#	0.03	0.06
Dissolved Zinc	mg/L		0.02^/0.04#	0.02	0.04

** See section 3.3*
^ Hardness modified trigger value, Upper Suttor River sub-catchment
 # Hardness modified trigger value, Rosella Creek sub-catchment

5 References

Australia and New Zealand Environment Conservation Council, 2000, Australian and New Zealand Guidelines for Fresh and Marine Water Quality.

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Appendix A

SUMMARY WATER QUALITY DATA

Table A.1 Summary data for BYSW1

BYSW1	Units	ANZECC Guideline	QWQG	20th Percentile	Min	Median	Max	80th Percentile	n	n-<LOR
pH(field)	pH units		6.5 - 8.0	8.57	8.55	8.60	8.65	8.63	2	0
pH(lab)	pH units		6.5 - 8.0	8.38	8.37	8.40	8.43	8.42	2	0
EC (field)	µS/cm		271	1060	1000	1150	1300	1240	2	0
EC (lab)	µS/cm		271	1216	1170	1285	1400	1354	2	0
Turbidity (lab)	NTU		50	34	34	35	35	35	2	0
TDS (lab)	mg/L			628	606	660	714	692	2	0
Dissolved Sulfate	mg/L	250		36	35	38	41	40	2	0
Total Aluminum	mg/L			1.710	1.700	1.725	1.750	1.740	2	0
Dissolved Aluminum	mg/L	0.055		0.010	0.010	0.010	0.010	0.010	2	0
Total Boron	mg/L			0.08	0.08	0.08	0.08	0.08	2	0
Dissolved Boron	mg/L	0.37		0.07	0.07	0.08	0.08	0.08	2	0
Total Copper	mg/L			0.0020	0.0020	0.0020	0.0020	0.0020	2	0
Dissolved Copper	mg/L	0.0014/0.0085*		0.0012	0.0010	0.0015	0.0020	0.0018	2	0
Total Manganese	mg/L			0.044	0.042	0.047	0.051	0.049	2	0
Dissolved Manganese	mg/L	1.9		0.001	0.001	0.002	0.003	0.003	2	1
Total Nickel	mg/L			0.005	0.005	0.006	0.007	0.007	2	0
Dissolved Nickel	mg/L	0.011/0.066*		0.002	0.002	0.003	0.004	0.004	2	0
Total Zinc	mg/L			0.006	0.005	0.008	0.011	0.010	2	1
Dissolved Zinc	mg/L	0.008/0.048*		0.005	0.005	0.006	0.006	0.006	2	1
Oxidized Nitrogen	mg/L		0.06	0.23	0.19	0.29	0.38	0.34	2	0
Total Nitrogen	mg/L		0.5	0.62	0.5	0.8	1.1	0.98	2	0
Total Phosphorus	mg/L		0.05	-	-	-	-	-	0	0

** Denotes Hardness Modified Trigger Value (HMTV) as per the ANZECC guidelines (2000) Table 3.4.3 and 3.4.4. The data has been compared against this modified trigger value.*

Table A.2 Summary data for BYSW2

BYSW2	Units	ANZECC Guideline	QWQG	20th Percentile	Min	Median	Max	80th Percentile	n	n-<LOR
pH(field)	pH units		6.5 - 7.5	7.87	7.80	8.22	8.70	8.38	5	0
pH(lab)	pH units		6.5 - 7.5	7.55	7.42	7.72	8.25	7.97	14	0
EC (field)	µS/cm		271	260	200	350	500	440	2	3
EC (lab)	µS/cm		271	136	98	177	340	284	14	0
Turbidity (lab)	NTU		25	173	115	280	1330	460	14	0
TDS (lab)	mg/L			314	273	364	999	504	14	0
Dissolved Sulfate	mg/L	250		3	2	5	18	8	14	0
Total Aluminum	mg/L			2.648	2.400	4.500	11.000	6.680	5	0
Dissolved Aluminum	mg/L	0.055		0.264	0.140	0.380	3.470	0.974	14	0
Total Boron	mg/L			0.06	0.06	0.07	0.09	0.08	5	0
Dissolved Boron	mg/L	0.37		0.06	0.05	0.07	0.09	0.08	14	0
Total Copper	mg/L			0.0060	0.0060	0.0070	0.0140	0.0084	5	0
Dissolved Copper	mg/L	0.0014/0.0022*		0.0026	0.0020	0.0030	0.0040	0.0040	14	0
Total Manganese	mg/L			0.031	0.025	0.034	0.079	0.046	5	0
Dissolved Manganese	mg/L	1.9		0.002	0.001	0.004	0.031	0.014	14	1
Total Nickel	mg/L			0.010	0.009	0.010	0.026	0.013	5	0
Dissolved Nickel	mg/L	0.011/0.017*		0.004	0.003	0.005	0.011	0.008	14	1
Total Zinc	mg/L			0.007	0.006	0.008	0.014	0.011	5	0
Dissolved Zinc	mg/L	0.008/0.013*		0.005	0.005	0.006	0.029	0.008	14	7
Oxidized Nitrogen	mg/L		0.015	0.02	0.01	0.02	0.07	0.03	11	3
Total Nitrogen	mg/L		0.25	0.80	0.6	1.0	1.8	1.36	14	0
Total Phosphorus	mg/L		0.03	0.35	0.35	0.35	0.35	0.35	1	0

** Denotes Hardness Modified Trigger Value (HMTV) as per the ANZECC guidelines (2000) Table 3.4.3 and 3.4.4. The data has been compared against this modified trigger value.*

Table A.3 Summary data for BYSW3

BYSW3	Units	ANZECC Guideline	QWQG	20th Percentile	Min	Median	Max	80th Percentile	n	n-<LOR
pH(field)	pH units		6.5 - 7.5	-					0	0
pH(lab)	pH units		6.5 - 7.5	7.53	7.38	7.75	8.20	7.92	9	0
EC (field)	µS/cm		271						0	0
EC (lab)	µS/cm		271	128	115	179	341	251	8	0
Turbidity (lab)	NTU		25	151	146	340	567	440	9	0
TDS (lab)	mg/L			293	208	315	394	348	9	0
Dissolved Sulfate	mg/L	250		5	2	9	14	10	10	0
Total Aluminum	mg/L			1.300	1.30	1.30	1.30	1.300	1	0
Dissolved Aluminum	mg/L	0.055		0.292	0.21	0.45	0.90	0.788	10	0
Total Boron	mg/L			0.08	0.08	0.08	0.08	0.08	1	0
Dissolved Boron	mg/L	0.37		0.05	0.05	0.05	0.09	0.08	10	6
Total Copper	mg/L			0.0062	0.0062	0.0062	0.0062	0.0062	1	0
Dissolved Copper	mg/L	0.0014/0.002*		0.0030	0.0020	0.0030	0.0050	0.0042	10	0
Total Manganese	mg/L			0.014	0.014	0.014	0.014	0.014	1	0
Dissolved Manganese	mg/L	1.9		0.001	0.001	0.002	0.052	0.003	10	1
Total Nickel	mg/L			0.009	0.009	0.009	0.009	0.009	1	0
Dissolved Nickel	mg/L	0.011/0.015*		0.004	0.004	0.004	0.008	0.005	10	0
Total Zinc	mg/L			0.006	0.006	0.006	0.006	0.006	1	0
Dissolved Zinc	mg/L	0.008/0.012*		0.005	0.004	0.006	0.010	0.006	10	5
Oxidized Nitrogen	mg/L		0.015	0.01	0.01	0.02	0.15	0.08	9	2
Total Nitrogen	mg/L		0.25	0.60	0.3	0.8	1.1	1.00	9	0
Total Phosphorus	mg/L		0.03	0.08	0.04	0.13	0.22	0.18	2	0

** Denotes Hardness Modified Trigger Value (HMTV) as per the ANZECC guidelines (2000) Table 3.4.3 and 3.4.4. The data has been compared against this modified trigger value.*

Table A.4 Summary data for BYSW5

BYSW5	Units	ANZECC Guideline	QWQG	20th Percentile	Min	Median	Max	80th Percentile	n	n-<LOR
pH(field)	**pH units**		**6.5 - 7.5**						0	0
pH(lab)	**pH units**		**6.5 - 7.5**	**7.57**	7.30	**7.74**	**8.20**	**7.89**	8	0
EC (field)	**µS/cm**		**168**						0	0
EC (lab)	**µS/cm**		**168**	165	136	**205.50**	**292**	**237**	8	0
Turbidity (lab)	**NTU**		**25**	12	11	**79.75**	**240**	**178**	8	0
TDS (lab)	**mg/L**			142	130	168	308	250	9	0
Dissolved Sulfate	**mg/L**	**250**		1	1	2	45	13	9	0
Total Aluminum	**mg/L**			1.900	1.90	1.90	1.90	1.900	1	0
Dissolved Aluminum	**mg/L**	**0.055**		**0.064**	0.03	**0.10**	**0.35**	**0.262**	9	0
Total Boron	**mg/L**			0.05	0.05	0.05	0.05	0.05	1	0
Dissolved Boron	**mg/L**	**0.37**		0.05	0.05	0.05	0.06	0.05	9	8
Total Copper	**mg/L**			0.0071	0.0071	0.0071	0.0071	0.0071	1	0
Dissolved Copper	**mg/L**	**0.0014/0.0027***		0.0020	0.0010	0.0020	**0.0050**	**0.0034**	9	0
Total Manganese	**mg/L**			0.137	0.137	0.137	0.137	0.137	1	0
Dissolved Manganese	**mg/L**	**1.9**		0.001	0.001	0.002	0.060	0.020	9	2
Total Nickel	**mg/L**			0.014	0.014	0.014	0.014	0.014	1	0
Dissolved Nickel	**mg/L**	**0.011/0.021***		0.004	0.004	0.006	0.009	0.007	9	0
Total Zinc	**mg/L**			0.009	0.009	0.009	0.009	0.009	1	0
Dissolved Zinc	**mg/L**	**0.008/0.015***		0.005	0.005	0.005	0.010	0.007	9	4
Oxidized Nitrogen	**mg/L**		**0.015**	0.01	0.01	**0.03**	**0.08**	**0.05**	8	3
Total Nitrogen	**mg/L**		**0.25**	**0.74**	**0.4**	**0.9**	**1.5**	**1.20**	8	0
Total Phosphorus	**mg/L**		**0.03**	**0.14**	**0.14**	**0.14**	**0.14**	**0.14**	1	0

** Denotes Hardness Modified Trigger Value (HMTV) as per the ANZECC guidelines (2000) Table 3.4.3 and 3.4.4. The data has been compared against this modified trigger value.*

Table A.5 Summary data for BYSW6

BYSW6	Units	ANZECC Guideline	QWQG	20th Percentile	Min	Median	Max	80th Percentile	n	n-<LOR
pH(field)	**pH units**		**6.5 - 7.5**	**8.07**	**7.84**	**8.14**	**8.23**	**8.18**	5	0
pH(lab)	**pH units**		**6.5 - 7.5**	**7.54**	7.22	**7.79**	**8.28**	**8.00**	13	0
EC (field)	**µS/cm**		**168**	90	90	100	**900**	**420**	5	2
EC (lab)	**µS/cm**		**168**	145	109	161	**1000**	**218**	13	0
Turbidity (lab)	**NTU**		**25**	8	4.5	45	**149**	**107**	13	0
TDS (lab)	**mg/L**			142	111	150	658	182	14	0
Dissolved Sulfate	**mg/L**	**250**		1	1	2	114	6	14	0
Total Aluminum	**mg/L**			0.290	0.23	0.79	3.10	1.650	6	0
Dissolved Aluminum	**mg/L**	**0.055**		0.040	0.02	**0.20**	**0.38**	**0.332**	14	0
Total Boron	**mg/L**			0.05	0.04	0.05	0.08	0.05	6	4
Dissolved Boron	**mg/L**	**0.37**		0.05	0.05	0.05	0.08	0.05	14	12
Total Copper	**mg/L**			0.0030	0.0030	0.0030	0.0120	0.0040	6	0
Dissolved Copper	**mg/L**	**0.0014/0.0022***		0.0020	0.0020	**0.0030**	**0.0067**	**0.0030**	14	0
Total Manganese	**mg/L**			0.011	0.011	0.023	0.130	0.039	6	0
Dissolved Manganese	**mg/L**	**1.9**		0.001	0.001	0.003	0.048	0.007	14	3
Total Nickel	**mg/L**			0.007	0.007	0.008	0.023	0.008	6	0
Dissolved Nickel	**mg/L**	**0.011/0.018***		0.005	0.003	0.006	0.011	0.006	14	0
Total Zinc	**mg/L**			0.005	0.005	0.015	0.023	0.023	6	2
Dissolved Zinc	**mg/L**	**0.008/0.013***		0.006	0.005	0.009	**0.017**	**0.013**	14	4
Oxidized Nitrogen	**mg/L**		**0.015**	0.01	0.01	0.01	**0.03**	**0.02**	13	5
Total Nitrogen	**mg/L**		**0.25**	**0.64**	0.1	**0.8**	**1.8**	**1.16**	13	0
Total Phosphorus	**mg/L**		**0.03**	**0.15**	**0.15**	**0.15**	**0.15**	**0.15**	1	0

** Denotes Hardness Modified Trigger Value (HMTV) as per the ANZECC guidelines (2000) Table 3.4.3 and 3.4.4. The data has been compared against this modified trigger value.*

Table A.6 Summary data for BYSW8

BYSW8	Units	ANZECC Guideline	QWQG	20th Percentile	Min	Median	Max	80th Percentile	n	n-<LOR
pH(field)	**pH units**		**6.5 - 7.5**	**7.98**	**7.92**	**8.08**	**8.24**	**8.18**	2	0
pH(lab)	**pH units**		**6.5 - 7.5**	**7.91**	**7.62**	**8.00**	**8.16**	**8.09**	11	0
EC (field)	**µS/cm**		**168**	**340**	300	**400**	**500**	**460**	2	0
EC (lab)	**µS/cm**		**168**	**168**	160	**335**	**810**	**741**	11	0
Turbidity (lab)	**NTU**		**25**	1	1.10	**55**	**200**	**140**	11	0
TDS (lab)	**mg/L**			186	170	230	462	434	11	0
Dissolved Sulfate	**mg/L**	**250**		1	1	5	27	23	11	0
Total Aluminum	**mg/L**			0.726	0.66	0.83	0.99	0.924	2	0
Dissolved Aluminum	**mg/L**	**0.055**		0.010	0.01	0.01	**0.41**	**0.200**	11	4
Total Boron	**mg/L**			0.06	0.06	0.06	0.06	0.06	2	0
Dissolved Boron	**mg/L**	**0.37**		0.05	0.05	0.06	0.11	0.10	11	4
Total Copper	**mg/L**			0.0020	0.0020	0.0020	0.0020	0.0020	2	0
Dissolved Copper	**mg/L**	**0.0014/0.005***		0.0010	0.0010	0.0020	0.0030	0.0020	11	2
Total Manganese	**mg/L**			0.034	0.031	0.038	0.045	0.042	2	0
Dissolved Manganese	**mg/L**	**1.9**		0.001	0.001	0.014	0.028	0.020	11	2
Total Nickel	**mg/L**			0.003	0.003	0.003	0.003	0.003	2	0
Dissolved Nickel	**mg/L**	**0.011/0.04***		0.002	0.001	0.002	0.005	0.002	11	0
Total Zinc	**mg/L**			0.005	0.005	0.006	0.007	0.007	2	1
Dissolved Zinc	**mg/L**	**0.008/0.03***		0.005	0.005	0.005	0.010	0.006	11	8
Oxidized Nitrogen	**mg/L**		**0.015**	0.01	0.01	0.01	**0.03**	**0.02**	11	4
Total Nitrogen	**mg/L**		**0.25**	0.10	0.1	**0.4**	**0.8**	**0.60**	11	2
Total Phosphorus	**mg/L**		**0.03**	**0.04**	**0.04**	**0.04**	**0.04**	**0.04**	1	0

** Denotes Hardness Modified Trigger Value (HMTV) as per the ANZECC guidelines (2000) Table 3.4.3 and 3.4.4. The data has been compared against this modified trigger value.*

Table A.7 Summary data for BYSW9

BYSW9	Units	ANZECC Guideline	QWQG	20th Percentile	Min	Median	Max	80th Percentile	n	n-<LOR
pH(field)	**pH units**		**6.5 - 8.0**	**8.15**	**8.00**	**8.47**	**9.10**	**8.62**	5	0
pH(lab)	**pH units**		**6.5 - 8.0**	7.10	7.04	7.15	7.53	7.48	5	0
EC (field)	**µS/cm**		**271**	90	90	200	200	200	5	2
EC (lab)	**µS/cm**		**271**	139	130	159	224	218	5	0
Turbidity (lab)	**NTU**		**50**	**190**	**186**	**266**	**425**	**305**	5	0
TDS (lab)	**mg/L**			362	355	440	533	498	5	0
Dissolved Sulfate	**mg/L**	**250**		4	2	5	5	5	5	0
Total Aluminum	**mg/L**			5.600	5.04	9.51	10.30	9.700	5	0
Dissolved Aluminum	**mg/L**	**0.055**		**0.298**	**0.29**	**0.35**	**2.31**	**0.806**	5	0
Total Boron	**mg/L**			0.06	0.05	0.06	0.06	0.06	5	1
Dissolved Boron	**mg/L**	**0.37**		0.06	0.05	0.06	0.06	0.06	5	1
Total Copper	**mg/L**			0.0010	0.0010	0.0010	0.0030	0.0030	5	1
Dissolved Copper	**mg/L**	**0.0014/0.0012***		**0.0018**	0.0010	**0.0020**	**0.0020**	**0.0020**	5	1
Total Manganese	**mg/L**			0.079	0.067	0.141	0.200	0.195	5	0
Dissolved Manganese	**mg/L**	**1.9**		0.047	0.035	0.080	0.179	0.156	5	0
Total Nickel	**mg/L**			0.003	0.003	0.003	0.004	0.003	5	0
Dissolved Nickel	**mg/L**	**0.011/0.0097***		0.001	0.001	0.001	0.002	0.002	5	0
Total Zinc	**mg/L**			0.005	0.005	0.006	0.009	0.007	5	1
Dissolved Zinc	**mg/L**	**0.008/0.007***		**0.007**	0.005	**0.012**	**0.014**	**0.012**	5	1
Oxidized Nitrogen	**mg/L**		**0.06**	0.03	0.01	**0.08**	**0.09**	**0.08**	5	1
Total Nitrogen	**mg/L**		**0.5**	**0.96**	**0.8**	**1.0**	**1.3**	**1.30**	5	0
Total Phosphorus	**mg/L**		**0.05**	-	-	-	-	-	0	0

** Denotes Hardness Modified Trigger Value (HMTV) as per the ANZECC guidelines (2000) Table 3.4.3 and 3.4.4.*

Table A.8 Summary data for BYSW18

BYSW18	Units	ANZECC Guideline	QWQG	20th Percentile	Min	Median	Max	80th Percentile	n	n-<LOR
pH(field)	**pH units**		**6.5 - 8.0**	**8.12**	**8.10**	**8.16**	**8.21**	**8.19**	2	0
pH(lab)	**pH units**		**6.5 - 8.0**	7.50	7.49	7.52	7.54	7.53	2	0
EC (field)	**µS/cm**		**271**	8	90	95	100	98	3	0
EC (lab)	**µS/cm**		**271**	136	121	160	198	183	4	0
Turbidity (lab)	**NTU**		**50**	**563**	**549.00**	**584.50**	**620.00**	**606**	4	0
TDS (lab)	**mg/L**			520	482	576	670	632	2	0
Hardness	**mg/L**			25	24	27	30	29	2	0
Dissolved Sulfate	**mg/L**	**250**		4	4	4	4	4	2	0
Total Aluminium	**mg/L**			8.340	7.95	8.93	9.90	9.510	2	0
Dissolved Aluminium	**mg/L**	**0.055**		**0.396**	**0.18**	**0.72**	**1.26**	**1.044**	2	0
Total Boron	**mg/L**			0.05	0.05	0.05	0.05	0.05	1	0
Dissolved Boron	**mg/L**	**0.37**		0.05	0.05	0.05	0.05	0.05	2	0
Total Copper	**mg/L**			0.0034	0.0030	0.0040	0.0050	0.0046	2	0
Dissolved Copper	**mg/L**	**0.0014/0.0013***		0.0010	0.0010	0.0010	0.0010	0.0010	2	0
Total Manganese	**mg/L**			0.117	0.088	0.160	0.231	0.202	2	0
Dissolved Manganese	**mg/L**	**1.9**		0.035	0.021	0.055	0.089	0.075	2	0
Total Nickel	**mg/L**			0.004	0.004	0.005	0.005	0.005	2	0
Dissolved Nickel	**mg/L**	**0.011/0.010***		0.002	0.002	0.002	0.002	0.002	2	0
Total Zinc	**mg/L**			0.011	0.010	0.014	0.017	0.016	2	0
Dissolved Zinc	**mg/L**	**0.008/0.007***		0.005	0.005	0.006	0.006	0.006	2	0
Oxidised Nitrogen	**mg/L**		**0.06**	0.04	0.03	0.05	**0.06**	0.05	2	0
Total Nitrogen	**mg/L**		**0.5**	0.46	0.40	**0.55**	**0.70**	**0.64**	2	0
Total Phosphorus	**mg/L**		**0.05**	-	-	-	-	-	0	0

** Denotes Hardness Modified Trigger Value (HMTV) as per the ANZECC guidelines (2000) Table 3.4.3 and 3.4.4.*

Table A.9 Summary data for PP32

PP32	Units	ANZECC Guideline	QWQG	20th Percentile	Min	Median	Max	80th Percentile	n	n-<LOR
pH(field)	**pH units**		**6.5 - 8.0**	**8.20**	**8.17**	**8.24**	**8.44**	**8.41**	6	0
pH(lab)	**pH units**		**6.5 - 8.0**	**8.21**	**8.19**	**8.38**	**8.53**	**8.44**	5	0
EC (field)	**µS/cm**		**271**	**296**	238	**522**	**1535**	**887**	6	0
EC (lab)	**µS/cm**		**271**	**295**	240	**431**	**939**	**745**	5	0
Turbidity (lab)	**NTU**		**50**	**89**	**89**	**89**	**128**	**113**	3	0
Sulfate dissolved	**mg/L**		**250**	11	9	26	62	57	5	0
Total Nitrogen	**mg/L**		**0.5**	0.01	0.01	0.01	0.31	0.16	5	3
TDS (lab)	**mg/L**			-	-	-	-	-	0	0
Dissolved Aluminium	**mg/L**	**0.055**		0.010	0.010	**0.070**	**0.170**	**0.098**	5	2
Dissolved Boron	**mg/L**	**0.37**		0.05	0.05	0.06	0.08	0.06	5	2
Dissolved Copper	**mg/L**	**0.0014/0.005***		0.0010	0.0010	0.0010	0.0020	0.0020	5	3
Dissolved Manganese	**mg/L**	**1.9**		-	-	--	-	-	0	0
Dissolved Nickel	**mg/L**	**0.011/0.04***		0.001	0.001	0.002	0.002	0.002	5	2
Dissolved Zinc	**mg/L**	**0.008/0.03***		0.005	0.005	0.005	0.005	0.005	5	5
Total Aluminium	**mg/L**			0.076	0.020	0.350	12.600	11.240	5	0
Total Boron	**mg/L**			0.05	0.05	0.06	0.07	0.06	5	2
Total Copper	**mg/L**			0.0018	0.0010	0.0030	0.0130	0.0090	5	1
Total Manganese	**mg/L**			-	-	--	-	-	0	0
Total Nickel	**mg/L**			0.003	0.001	0.003	0.031	0.015	5	1
Total Zinc	**mg/L**			0.005	0.005	0.005	0.029	0.019	5	3

** Denotes Hardness Modified Trigger Value (HMTV) as per the ANZECC guidelines (2000) Table 3.4.3 and 3.4.4. The data has been compared against this modified trigger value.*

Table A.10 Summary data for PP33

PP33	Units	ANZECC Guideline	QWQG	20th Percentile	Min	Median	Max	80th Percentile	n	n-<LOR
pH(field)	**pH units**		**6.5 - 8.0**	**8.20**	7.51	**8.43**	**8.76**	**8.59**	10	0
pH(lab)	**pH units**		**6.5 - 8.0**	**8.30**	**8.22**	**8.34**	**8.56**	**8.50**	9	0
EC (field)	**µS/cm**		**271**	**402**	**280**	**465**	**6363**	**962**	10	0
EC (lab)	**µS/cm**		**271**	**467**	**399**	**622**	**1790**	**735**	9	0
Turbidity (lab)	**NTU**		**50**	**51**	26	**90**	**168**	**137**	3	0
Sulfate dissolved	**mg/L**		**250**	13	8	30	222	43	9	0
Total Nitrogen	**mg/L**		**0.5**	0.01	0.01	0.01	**0.54**	0.04	10	5
TDS (lab)	**mg/L**			262.80	262.00	264.00	266.00	265.20	2	0
Dissolved Aluminium	**mg/L**	**0.055**		0.010	0.010	0.010	**0.200**	0.040	6	4
Dissolved Boron	**mg/L**	**0.37**		0.06	0.05	0.07	0.10	0.10	10	5
Dissolved Copper	**mg/L**	**0.0014/0.006***		0.0020	0.0010	0.0020	**0.0080**	0.0020	9	1
Dissolved Manganese	**mg/L**	**1.9**		-	-	-	-	-	0	0
Dissolved Nickel	**mg/L**	**0.011/0.05***		0.001	0.001	0.001	0.003	0.001	9	8
Dissolved Zinc	**mg/L**	**0.008/0.04***		0.005	0.005	0.005	0.012	0.009	10	6
Total Aluminium	**mg/L**			0.106	0.070	0.260	2.400	1.692	7	0
Total Boron	**mg/L**			0.05	0.05	0.07	0.11	0.10	10	6
Total Copper	**mg/L**			0.0020	0.0010	0.0020	0.0090	0.0032	10	1
Total Manganese	**mg/L**			-	-	-	-	-	0	0
Total Nickel	**mg/L**			0.001	0.001	0.002	0.007	0.004	10	4
Total Zinc	**mg/L**			0.005	0.005	0.005	0.012	0.009	9	6

** Denotes Hardness Modified Trigger Value (HMTV) as per the ANZECC guidelines (2000) Table 3.4.3 and 3.4.4. The data has been compared against this modified trigger value.*

Table A.11 Summary data for PP34

PP34	Units	ANZECC Guideline	QWQG	20th Percentile	Min	Median	Max	80th Percentile	n	n-<LOR
pH(field)	**pH units**		**6.5 - 8.0**	**8.27**	**8.14**	**8.47**	**9.11**	**8.67**	6	0
pH(lab)	**pH units**		**6.5 - 8.0**	**8.33**	7.93	**8.40**	**8.84**	**8.69**	7	0
EC (field)	**µS/cm**		**271**	**362**	**330**	**393**	**543**	**477**	6	0
EC (lab)	**µS/cm**		**271**	**384**	**357**	**509**	**1460**	**657**	7	0
Turbidity (lab)	**NTU**		**50**	46	13	**95**	**178**	**145**	2	0
Sulfate dissolved	**mg/L**		**250**	10	5	16	71	31	7	0
Total Nitrogen	**mg/L**		**0.5**	0.01	0.01	0.01	0.02	0.01	7	6
TDS (lab)	**mg/L**			261.00	261.00	261.00	261.00	261.00	1	0
Dissolved Aluminium	**mg/L**	**0.055**		0.010	0.010	0.010	**0.080**	0.020	6	4
Dissolved Boron	**mg/L**	**0.37**		0.05	0.05	0.06	0.22	0.10	7	4
Dissolved Copper	**mg/L**	**0.0014/0.005***		0.0012	0.0010	0.0020	0.0040	0.0020	7	2
Dissolved Manganese	**mg/L**	**1.9**		-	-	-	-	-	0	0
Dissolved Nickel	**mg/L**	**0.011/0.04***		0.001	0.001	0.001	0.002	0.001	7	6
Dissolved Zinc	**mg/L**	**0.008/0.03***		0.005	0.005	0.005	0.005	0.005	7	7
Total Aluminium	**mg/L**			0.210	0.190	0.420	3.570	2.670	6	0
Total Boron	**mg/L**			0.05	0.05	0.06	0.19	0.10	7	4
Total Copper	**mg/L**			0.0020	0.0020	0.0020	0.0080	0.0030	7	0
Total Manganese	**mg/L**			-	-	-	-	-	0	0
Total Nickel	**mg/L**			0.001	0.001	0.001	0.007	0.005	7	4
Total Zinc	**mg/L**			0.005	0.005	0.005	0.013	0.006	7	5

** Denotes Hardness Modified Trigger Value (HMTV) as per the ANZECC guidelines (2000) Table 3.4.3 and 3.4.4. The data has been compared against this modified trigger value.*

Table A.12 Summary data for FSS03

FSS03	Units	ANZECC Guideline	QWQG	20th Percentile	Min	Median	Max	80th Percentile	n	n-<LOR
pH(field)	**pH units**		**6.5 - 7.5**	**7.95**	6.82	**8.27**	**8.87**	**8.46**	46	0
pH(lab)	**pH units**		**6.5 - 7.5**	**7.92**	**7.69**	**8.20**	**8.56**	**8.36**	43	0
EC (field)	**µS/cm**		**271**	267	106	**1079**	**9894**	**3730**	46	0
EC (lab)	**µS/cm**		**271**	249	158	**1200**	**9000**	**3714**	42	0
Turbidity (lab)	**NTU**		**25**	7	1	**45**	**1820**	**615**	21	0
Sulfate dissolved	**mg/L**		**250**	15	1	171	**795**	**467**	42	2
Total Nitrogen	**mg/L**		**0.25**	0.01	0.01	0.04	**1.79**	0.14	41	10
TDS (lab)	**mg/L**			143.40	135.00	156.00	177.00	168.60	2	0
Dissolved Aluminium	**mg/L**	**0.055**		0.010	0.010	0.010	**2.200**	**0.090**	41	22
Dissolved Boron	**mg/L**	**0.37**		0.05	0.05	0.06	0.17	0.12	41	19
Dissolved Copper	**mg/L**	**0.0014/0.008***		0.0010	0.0010	0.0020	0.0060	0.0020	42	13
Dissolved Manganese	**mg/L**	**1.9**		0.00	0.00	0.00	0.00	0.00	1	0
Dissolved Nickel	**mg/L**	**0.011/0.06***		0.002	0.001	0.004	0.013	0.006	42	3
Dissolved Zinc	**mg/L**	**0.008/0.05***		0.005	0.005	0.005	0.185	0.010	42	30
Total Aluminium	**mg/L**			0.080	0.020	1.450	42.300	9.200	41	0
Total Boron	**mg/L**			0.05	0.05	0.06	0.19	0.12	41	20
Total Copper	**mg/L**			0.0020	0.0010	0.0030	0.0360	0.0088	42	5
Total Manganese	**mg/L**			0.3	0.3	0.3	0.3	0.3	1	0
Total Nickel	**mg/L**			0.005	0.001	0.009	0.079	0.022	42	1
Total Zinc	**mg/L**			0.005	0.005	0.010	0.196	0.045	42	17

** Denotes Hardness Modified Trigger Value (HMTV) as per the ANZECC guidelines (2000) Table 3.4.3 and 3.4.4. The data has been compared against this modified trigger value.*

Table A.13 Summary data for FSS04

FSS04	Units	ANZECC Guideline	QWQG	20th Percentile	Min	Median	Max	80th Percentile	n	n-<LOR
pH(field)	**pH units**		**6.5 - 8.0**	**8.13**	7.54	**8.28**	**8.90**	**8.43**	211	0
pH(lab)	**pH units**		**6.5 - 8.0**	**8.23**	6.55	**8.38**	**8.60**	**8.48**	208	0
EC (field)	**µS/cm**		**271**	**1010**	120	**1653**	**4664**	**2817**	211	0
EC (lab)	**µS/cm**		**271**	**1130**	132	**1755**	**4170**	**2886**	208	0
Turbidity (lab)	**NTU**		**50**	12	0	23	**1649**	**96**	113	0
Sulfate dissolved	**mg/L**		**250**	122	2	233	**1440**	**456**	209	0
Total Nitrogen	**mg/L**		**0.5**	0.02	0.01	0.12	**5.94**	**0.56**	75	12
TDS (lab)	**mg/L**			700.00	232.00	2540.00	4680.00	2910.00	11	0
Dissolved Aluminium	**mg/L**	**0.055**		0.010	0.010	0.010	**7.790**	**0.106**	75	38
Dissolved Boron	**mg/L**	**0.37**		0.05	0.05	0.07	0.16	0.10	73	32
Dissolved Copper	**mg/L**	**0.0014/0.008***		0.0010	0.0001	0.0010	0.0310	0.0020	79	43
Dissolved Manganese	**mg/L**	**1.9**		0.00	0.00	0.00	0.02	0.01	32	5
Dissolved Nickel	**mg/L**	**0.011/0.06***		0.002	0.001	0.003	**0.063**	0.006	79	6
Dissolved Zinc	**mg/L**	**0.008/0.04***		0.005	0.005	0.005	**0.048**	0.005	79	64
Total Aluminium	**mg/L**			0.110	0.010	0.510	94.700	5.174	72	3
Total Boron	**mg/L**			0.05	0.05	0.07	0.14	0.10	73	34
Total Copper	**mg/L**			0.0010	0.0010	0.0020	0.0790	0.0070	76	23
Total Manganese	**mg/L**			0.0	0.0	0.0	0.5	0.1	32	1
Total Nickel	**mg/L**			0.002	0.001	0.008	0.182	0.015	75	6
Total Zinc	**mg/L**			0.005	0.005	0.005	0.196	0.020	75	39

** Denotes Hardness Modified Trigger Value (HMTV) as per the ANZECC guidelines (2000) Table 3.4.3 and 3.4.4. The data has been compared against this modified trigger value.*

Table A.14 Summary data for FSS05

FSS05	Units	ANZECC Guideline	QWQG	20th Percentile	Min	Median	Max	80th Percentile	n	n-<LOR
pH(field)	**pH units**		**6.5 - 8.0**	**8.09**	7.59	**8.25**	**9.18**	**8.42**	84	0
pH(lab)	**pH units**		**6.5 - 8.0**	**8.09**	6.81	**8.36**	**8.56**	**8.51**	35	0
EC (field)	**µS/cm**		**271**	**710**	66	**1133**	**3375**	**1217**	84	0
EC (lab)	**µS/cm**		**271**	181	69	**1185**	**1980**	**1270**	34	0
Turbidity (lab)	**NTU**		**50**	2	0	7	**161**	40	56	0
Sulfate dissolved	**mg/L**		**250**	4	1	18	**504**	23	35	1
Total Nitrogen	**mg/L**		**0.5**	0.01	0.01	0.08	**1.45**	0.23	31	7
TDS (lab)	**mg/L**			246.40	228.00	274.00	1930.00	1267.60	3	0
Dissolved Aluminium	**mg/L**	**0.055**		0.010	0.010	0.020	**2.450**	0.050	31	12
Dissolved Boron	**mg/L**	**0.37**		0.05	0.05	0.06	0.20	0.08	32	15
Dissolved Copper	**mg/L**	**0.0014/0.007***		0.0010	0.0001	0.0010	**0.0080**	0.0030	33	17
Dissolved Manganese	**mg/L**	**1.9**		0.00	0.00	0.00	0.02	0.01	16	4
Dissolved Nickel	**mg/L**	**0.011/0.06***		0.001	0.001	0.002	0.007	0.004	33	15
Dissolved Zinc	**mg/L**	**0.008/0.04***		0.005	0.005	0.005	0.023	0.005	32	26
Total Aluminium	**mg/L**			0.038	0.010	0.105	19.000	3.020	30	1
Total Boron	**mg/L**			0.05	0.05	0.06	0.16	0.08	32	17
Total Copper	**mg/L**			0.0010	0.0010	0.0020	0.0190	0.0060	32	15
Total Manganese	**mg/L**			0.00	0.00	0.01	0.03	0.01	16	1
Total Nickel	**mg/L**			0.001	0.001	0.003	0.052	0.013	31	14
Total Zinc	**mg/L**			0.005	0.005	0.005	0.054	0.016	31	16

** Denotes Hardness Modified Trigger Value (HMTV) as per the ANZECC guidelines (2000) Table 3.4.3 and 3.4.4. The data has been compared against this modified trigger value.*

Table A.15 Summary data for FSS07

FSS07	Units	ANZECC Guideline	QWQG	20th Percentile	Min	Median	Max	80th Percentile	n	n-<LOR
pH(field)	**pH units**		**6.5 - 8.0**	7.76	7.11	**8.02**	**9.10**	**8.31**	66	0
pH(lab)	**pH units**		**6.5 - 8.0**	7.81	6.70	**8.05**	**8.62**	**8.21**	62	0
EC (field)	**µS/cm**		**168**	**248**	67	**619**	**4462**	**1561**	66	0
EC (lab)	**µS/cm**		**168**	**267**	90	**551**	**3960**	**2040**	62	0
Turbidity (lab)	**NTU**		**50**	17	1	**87**	**570**	**151**	16	0
Sulfate dissolved	**mg/L**		**250**	2	1	5	44	9	58	1
Total Nitrogen	**mg/L**		**0.5**	0.02	0.01	0.15	**0.51**	0.28	8	2
TDS (lab)	**mg/L**			252.40	116.00	434.00	1680.00	925.60	17	0
Dissolved Aluminium	**mg/L**	**0.055**		0.010	0.010	0.025	**5.990**	**0.250**	56	24
Dissolved Boron	**mg/L**	**0.37**		0.07	0.05	0.10	0.10	0.10	8	8
Dissolved Copper	**mg/L**	**0.0014/0.003***		0.0010	0.0010	0.0020	0.0280	0.0028	57	23
Dissolved Manganese	**mg/L**	**1.9**		-	-	-	-	-	0	0
Dissolved Nickel	**mg/L**	**0.011/0.03***		0.001	0.001	0.001	**0.037**	0.002	57	37
Dissolved Zinc	**mg/L**	**0.008/0.02***		0.005	0.005	0.005	**0.042**	0.007	57	44
Total Aluminium	**mg/L**			0.100	0.010	0.695	78.4	5.140	46	3
Total Boron	**mg/L**			0.07	0.05	0.10	0.10	0.10	8	8
Total Copper	**mg/L**			0.0012	0.0010	0.0030	0.0640	0.0108	47	10
Total Manganese	**mg/L**			-	-	-	-	-	0	0
Total Nickel	**mg/L**			0.001	0.001	0.003	0.117	0.008	47	14
Total Zinc	**mg/L**			0.005	0.005	0.009	0.211	0.025	47	19

** Denotes Hardness Modified Trigger Value (HMTV) as per the ANZECC guidelines (2000) Table 3.4.3 and 3.4.4.*

Table A.16 Summary data for FSS08

FSS08	Units	ANZECC Guideline	QWQG	20th Percentile	Min	Median	Max	80th Percentile	n	n-<LOR
pH(field)	**pH units**		**6.5 - 8.0**	**8.11**	6.84	**8.34**	**9.12**	**8.57**	303	0
pH(lab)	**pH units**		**6.5 - 8.0**	7.98	7.36	**8.34**	**8.78**	**8.55**	222	0
EC (field)	**uS/cm**		**168**	**493**	20	**761**	**2723**	**1462**	303	0
EC (lab)	**uS/cm**		**168**	**461**	131	**882**	**3090**	**1558**	222	0
Turbidity (lab)	**NTU**		**50**	7	0	**70**	**1250**	**203**	117	0
Sulfate dissolved	**mg/L**		**250**	14	2	52	**257**	99	220	2
Total Nitrogen	**mg/L**		**0.5**	0.03	0.01	0.26	**2.01**	**0.68**	36	6
TDS (lab)	**mg/L**			295.20	112.00	391.50	781.00	484.40	18	0
Dissolved Aluminium	**mg/L**	**0.055**		0.010	0.010	0.020	**4.100**	**0.160**	81	33
Dossolved Boron	**mg/L**	**0.37**		0.05	0.05	0.09	0.19	0.11	36	16
Dissolved Copper	**mg/L**	**0.0014/0.003***		0.0010	0.0010	0.0020	**0.0200**	**0.0030**	82	21
Dissolved Manganese	**mg/L**	**1.9**		0.0	0.0	0.0	0.1	0.0	30	9
Dissolved Nickel	**mg/L**	**0.011/0.03***		0.001	0.001	0.002	0.029	0.002	82	19
Dissolved Zinc	**mg/L**	**0.008/0.02***		0.005	0.005	0.005	**0.022**	0.005	82	70
Total Aluminium	**mg/L**			0.148	0.020	1.890	56.800	5.502	73	0
Total Boron	**mg/L**			0.05	0.05	0.09	0.21	0.12	37	14
Total Copper	**mg/L**			0.0020	0.0010	0.0040	0.0620	0.0080	74	12
Total Manganese	**mg/L**			0.0	0.0	0.1	1.0	0.2	31	0
Total Nickel	**mg/L**			0.002	0.001	0.005	0.104	0.011	73	9
Total Zinc	**mg/L**			0.005	0.005	0.006	0.140	0.021	73	31

** Denotes Hardness Modified Trigger Value (HMTV) as per the ANZECC guidelines (2000) Table 3.4.3 and 3.4.4. The data has been compared against this modified trigger value.*

Table A.17 Summary data for FSS14

FSS14	Units	ANZECC Guideline	QWQG	20th Percentile	Min	Median	Max	80th Percentile	n	n-<LOR
pH(field)	**pH units**		**6.5 - 8.0**	**8.21**	**8.00**	**8.33**	**9.03**	**8.47**	149	0
pH(lab)	**pH units**		**6.5 - 8.0**	**8.30**	6.94	**8.44**	**8.60**	**8.52**	148	0
EC (field)	**µS/cm**		**271**	**1363**	**395**	**2071**	**3420**	**2702**	149	0
EC (lab)	**µS/cm**		**271**	**1338**	**409**	**1960**	**3460**	**2626**	148	0
Turbidity (lab)	**NTU**		**50**	13	0	36	**2229**	**136**	83	0
Sulfate dissolved	**mg/L**		**250**	142	29	242	**573**	**408**	147	0
Total Nitrogen	**mg/L**		**0.5**	0.02	0.01	0.19	**1.90**	**0.72**	34	7
TDS (lab)	**mg/L**			-	-	-	-	-	0	0
Dissolved Aluminium	**mg/L**	**0.055**		0.010	0.010	0.010	**1.910**	**0.076**	33	18
Dissolved Boron	**mg/L**	**0.37**		0.05	0.05	0.08	0.12	0.10	33	10
Dissolved Copper	**mg/L**	**0.0014/0.01***		0.0010	0.0010	0.0010	0.0040	0.0020	33	17
Dissolved Manganese	**mg/L**	**1.9**		0.00	0.00	0.00	0.01	0.01	30	8
Dissolved Nickel	**mg/L**	**0.011/0.08***		0.001	0.001	0.003	0.007	0.005	33	8
Dissolved Zinc	**mg/L**	**0.008/0.06***		0.005	0.005	0.005	0.006	0.005	33	32
Total Aluminium	**mg/L**			0.042	0.010	0.720	30.6	4.720	33	4
Total Boron	**mg/L**			0.06	0.05	0.08	0.54	0.12	33	6
Total Copper	**mg/L**			0.0010	0.0010	0.0020	0.032	0.0078	33	10
Total Manganese	**mg/L**			0.0	0.0	0.0	0.8	0.2	30	0
Total Nickel	**mg/L**			0.002	0.001	0.007	0.068	0.014	33	6
Total Zinc	**mg/L**			0.005	0.005	0.006	0.070	0.019	33	14

** Denotes Hardness Modified Trigger Value (HMTV) as per the ANZECC guidelines (2000) Table 3.4.3 and 3.4.4. The data has been compared against this modified trigger value.*

Table A.18 Summary data for FSS15

FSS15	Units	ANZECC Guideline	QWQG	20th Percentile	Min	Median	Max	80th Percentile	n	n-<LOR
pH(field)	**pH units**		**6.5 - 8.0**	**8.04**	7.48	**8.26**	**8.88**	**8.52**	173	0
pH(lab)	**pH units**		**6.5 - 8.0**	**8.10**	7.58	**8.39**	**8.70**	**8.53**	172	0
EC (field)	**µS/cm**		**271**	**746**	141	**1750**	**2680**	**2207**	173	0
EC (lab)	**µS/cm**		**271**	**761**	157	**1595**	**2690**	**2108**	172	0
Turbidity (lab)	**NTU**		**50**	9	0	27	**2529**	**550**	81	0
Sulfate dissolved	**mg/L**		**250**	51	1	155	**396**	232	171	0
Total Nitrogen	**mg/L**		**0.5**	0.01	0.01	0.03	0.49	0.16	33	12
TDS (lab)	**mg/L**			-	-	-	-	-	0	0
Dissolved Aluminium	**mg/L**	**0.055**		0.010	0.010	0.010	**1.490**	**0.072**	35	24
Dissolved Boron	**mg/L**	**0.37**		0.05	0.05	0.08	0.12	0.09	34	14
Dissolved Copper	**mg/L**	**0.0014/0.01***		0.0010	0.0010	0.0020	0.0050	0.0020	35	14
Dissolved Manganese	**mg/L**	**1.9**		0.0	0.0	0.0	0.1	0.0	32	10
Dissolved Nickel	**mg/L**	**0.011/0.09***		0.002	0.001	0.002	0.006	0.003	35	5
Dissolved Zinc	**mg/L**	**0.008/0.07***		0.005	0.005	0.005	0.031	0.005	35	30
Total Aluminium	**mg/L**			0.156	0.050	0.730	35.4	15.920	34	0
Total Boron	**mg/L**			0.05	0.05	0.08	0.13	0.10	33	10
Total Copper	**mg/L**			0.0010	0.0010	0.0025	0.0390	0.0182	34	12
Total Manganese	**mg/L**			0.0	0.0	0.1	1.0	0.6	32	0
Total Nickel	**mg/L**			0.003	0.002	0.005	0.072	0.025	34	0
Total Zinc	**mg/L**			0.005	0.005	0.011	0.089	0.038	34	14

** Denotes Hardness Modified Trigger Value (HMTV) as per the ANZECC guidelines (2000) Table 3.4.3 and 3.4.4. The data has been compared against this modified trigger value.*

Table A.19 Summary data for FSS16

FSS16	Units	ANZECC Guideline	QWQG	20th Percentile	Min	Median	Max	80th Percentile	n	n-<LOR
pH(field)	**pH units**		**6.5 - 8.0**	7.43	7.07	7.58	**8.53**	7.90	31	12
pH(lab)	**pH units**		**6.5 - 8.0**	7.84	7.48	7.99	**8.51**	**8.13**	32	16
EC (field)	**µS/cm**		**168**	**335**	110	**449**	**10670**	**857**	31	4
EC (lab)	**µS/cm**		**168**	**313**	150	**684**	**1280**	**884**	32	0
Turbidity (lab)	**NTU**		**50**	9	2	16	**577**	**198**	19	2
Sulfate dissolved	**mg/L**		**250**	12	1	18	51	38	31	0
Total Nitrogen	**mg/L**		**0.5**	0.03	0.01	0.09	**0.90**	0.16	28	0
TDS (lab)	**mg/L**			-	-	-	-	-	0	0
Dissolved Aluminium	**mg/L**	**0.055**		0.010	0.010	**0.070**	**3.250**	**0.530**	31	0
Dissolved Boron	**mg/L**	**0.37**		0.05	0.05	0.06	0.10	0.07	28	0
Dissolved Copper	**mg/L**	**0.0014/0.002***		0.0010	0.0010	0.0010	**0.0120**	**0.0020**	31	0
Dissolved Manganese	**mg/L**	**1.9**		0.0	0.0	0.0	0.8	0.4	27	0
Dissolved Nickel	**mg/L**	**0.011/0.02***		0.002	0.001	0.002	0.003	0.002	31	0
Dissolved Zinc	**mg/L**	**0.008/0.01***		0.005	0.005	0.005	**0.034**	0.007	31	0
Total Aluminium	**mg/L**			0.180	0.080	1.660	13.300	5.890	31	0
Total Boron	**mg/L**			0.05	0.05	0.06	0.10	0.08	28	0
Total Copper	**mg/L**			0.0010	0.0010	0.0020	0.0100	0.0070	31	0
Total Manganese	**mg/L**			0.1	0.1	0.3	0.9	0.5	27	0
Total Nickel	**mg/L**			0.002	0.002	0.003	0.014	0.008	31	0
Total Zinc	**mg/L**			0.005	0.005	0.007	0.060	0.020	31	0

** Denotes Hardness Modified Trigger Value (HMTV) as per the ANZECC guidelines (2000) Table 3.4.3 and 3.4.4. The data has been compared against this modified trigger value.*

Table A.20 Summary data for WQS03

WQS03	Units	ANZECC Guideline	QWQG	20th Percentile	Min	Median	Max	80th Percentile	n	n-<LOR
pH(field)	**pH units**		**6.5 - 8.0**	7.96	7.95	7.98	**8.00**	7.99	2	0
pH(lab)	**pH units**		**6.5 - 8.0**	**8.10**	7.78	**8.24**	**8.40**	**8.32**	6	0
EC (field)	**µS/cm**		**168**	148	145	152	158	155	2	0
EC (lab)	**µS/cm**		**168**	141	116	145	**342**	149	6	0
Turbidity (lab)	**NTU**		**50**	-	-	-	-	-	0	0
Sulfate dissolved	**mg/L**		**250**	4	3	4	12	5	8	0
Total Nitrogen	**mg/L**		**0.5**	0.01	0.01	0.01	0.05	0.03	7	5
TDS (lab)	**mg/L**			-	-	-	-	-	0	0
Dissolved Aluminium	**mg/L**	**0.055**		**0.128**	**0.080**	**0.230**	**0.280**	**0.268**	7	0
Dissolved Boron	**mg/L**	**0.37**		0.05	0.05	0.05	0.05	0.05	7	7
Dissolved Copper	**mg/L**	**0.0014/0.02***		0.0012	0.0010	0.0020	0.0030	0.0020	7	2
Dissolved Manganese	**mg/L**	**1.9**		-	-	-	-	-	0	0
Dissolved Nickel	**mg/L**	**0.011/0.14***		0.001	0.001	0.001	0.003	0.003	7	4
Dissolved Zinc	**mg/L**	**0.008/0.10***		0.005	0.005	0.005	0.006	0.005	7	6
Total Aluminium	**mg/L**			1.084	0.560	2.980	136.000	71.240	7	0
Total Boron	**mg/L**			0.05	0.05	0.05	0.10	0.07	7	6
Total Copper	**mg/L**			0.0052	0.0030	0.0080	0.0960	0.0690	7	0
Total Manganese	**mg/L**			-	-	-	-	-	0	0
Total Nickel	**mg/L**			0.004	0.003	0.007	0.246	0.192	7	0
Total Zinc	**mg/L**			0.006	0.005	0.011	0.220	0.149	7	1

** Denotes Hardness Modified Trigger Value (HMTV) as per the ANZECC guidelines (2000) Table 3.4.3 and 3.4.4. The data has been compared against this modified trigger value.*

Table A.21 Summary data for WQS05

WQS5	Units	ANZECC Guideline	QWQG	20th Percentile	Min	Median	Max	80th Percentile	n	n<LOR
pH(field)	**pH units**		**6.5 - 8.0**	7.84	7.84	7.84	7.84	7.84	1	0
pH(lab)	**pH units**		**6.5 - 8.0**	7.52	7.41	7.79	**8.10**	7.93	21	0
EC (field)	**µS/cm**		**271**	**286**	**286**	**286**	**286**	**286**	1	0
EC (lab)	**µS/cm**		**271**	169	138	256	**465**	**316**	21	0
Turbidity (lab)	**NTU**		**50**	-	-	-	-	-	0	0
Sulfate dissolved	**mg/L**		**250**	4	1	10	88	30	21	0
Total Nitrogen	**mg/L**		**0.5**	0.02	0.01	0.04	0.25	0.08	18	3
TDS (lab)	**mg/L**			-	-	-	-	-	0	0
Dissolved Aluminium	**mg/L**	**0.055**		0.040	0.010	**0.090**	**1.430**	**0.220**	21	2
Dissolved Boron	**mg/L**	**0.37**		0.05	0.05	0.05	0.05	0.05	21	21
Dissolved Copper	**mg/L**	**0.0014/0.003***		0.0020	0.0010	0.0020	**0.0040**	0.0020	21	1
Dissolved Manganese	**mg/L**	**1.9**		-	-	-	-	-	0	0
Dissolved Nickel	**mg/L**	**0.011/0.02***		0.002	0.001	0.004	0.016	0.004	21	1
Dissolved Zinc	**mg/L**	**0.008/0.02***		0.005	0.005	0.005	0.005	0.005	21	21
Total Aluminium	**mg/L**			5.900	3.6	36	122	92.3	21	0
Total Boron	**mg/L**			0.05	0.05	0.05	0.05	0.05	21	21
Total Copper	**mg/L**			0.0070	0.0050	0.0530	0.1560	0.1000	21	0
Total Manganese	**mg/L**			-	-	-	-	-	0	0
Total Nickel	**mg/L**			0.016	0.010	0.118	0.382	0.232	21	0
Total Zinc	**mg/L**			0.021	0.012	0.112	0.270	0.186	21	0

** Denotes Hardness Modified Trigger Value (HMTV) as per the ANZECC guidelines (2000) Table 3.4.3 and 3.4.4. The data has been compared against this modified trigger value.*