Chapter 15

Surface Water Quality

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15. SURFACE WATER QUALITY

15.1 Introduction

This chapter describes existing surface water quality, it defines the environmental values and protection objectives and describes management and mitigation for all identified impacts.

The chapter summarises the results of various water quality monitoring programs to define the baseline water quality and is also informed by the results of a site visit undertaken in September 2012.

The identified draft site water quality objectives (WQOs) are linked to the mine water management strategy to develop a water release and monitoring program for inclusion in the project Environmental Management Plan (EMP).

The Project Approvals chapter (**Chapter 3**) describes the legislation, regulation, policy and guidance of relevance to the overall project. The following regulatory framework is identified in **Chapter 3** as relevant to surface water:

- *Water Act 2000*
- Environmental Protection (Water) Policy 2009 (EPP (Water))
- Water Resource (Burdekin Basin) Plan 2007
- Water Quality Guidelines and Assessment Tools:
  - The Australian and New Zealand Environment Conservation Council (ANZECC) guidelines
  - Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ) Guidelines
  - The Queensland Water Quality Guidelines (QWQG) (DERM, 2009).

This study draws on inputs from a range of other studies that have been completed for the project. Detailed methodology and limitations are set out in the following reports:

- Mine Water Management Strategy (**Appendix 11**)
- Geochemical Assessment of Spoil and Potential Coal Reject Materials(**Appendix 12**)
- Assessment of Surface Water Environmental Values (**Appendix 16**)
- Hydrology and Flooding Assessment (**Appendix 17**)
- Environmental Impact Assessment Groundwater Aspects (**Appendix 18**)
- Aquatic Ecology Impact Assessment (**Appendix 19**).

Management of treated effluent is described in the waste management chapter of the EIS (**Chapter 26**), with irrigation to land considered as a potential option.

Environmental Values (EVs) for Rosella Creek and Upper Suttor River sub-catchments, based on the EPP Water requirements, are identified and a set of Water Quality Objectives (WQOs) for the project derived.

WQOs are informed by site sampling data, baseline water quality monitoring data and literature provided in the Burdekin Water Quality Improvement Plan (2009) (Burdekin WQIP).

Draft WQOs are the basis for developing the mine water release criteria and release limits provided in **Chapter 8**. Trigger investigation levels are also stipulated for downstream compliance points.

Chapter 8 outlines the mine water system design basis for the project primarily as involving segregation of water types based on water quality and describes the release strategy which has been developed.

Expected water quality from the Suttor River and Kangaroo Creek catchments is included in the water balance model and water quality inferences are made from surface water monitoring, geochemical waste rock investigations and groundwater monitoring data, which were used to estimate the likely quality of water both within the mine site and in the receiving environment.

Underground mining is not being considered as part of the project (detail regarding the removal of underground mining as part of the project is provided in **Chapter 1, Section 1.12**. Accordingly the potential issue of subsidence associated with underground mining is no longer relevant to the project. However a qualitative engineering review was undertaken by the proponent to ascertain if any other project aspects pose potential subsidence risks, including, open cut mining, water infrastructure, MIA, CHPP and linear infrastructure. No subsidence related impacts are expected to arise as a result of the project; therefore, there will be no surface water related impacts associated with subsidence from the project.

15.2 Catchment Description

15.2.1 Climate

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 (refer to **Chapters 12** and **16**).

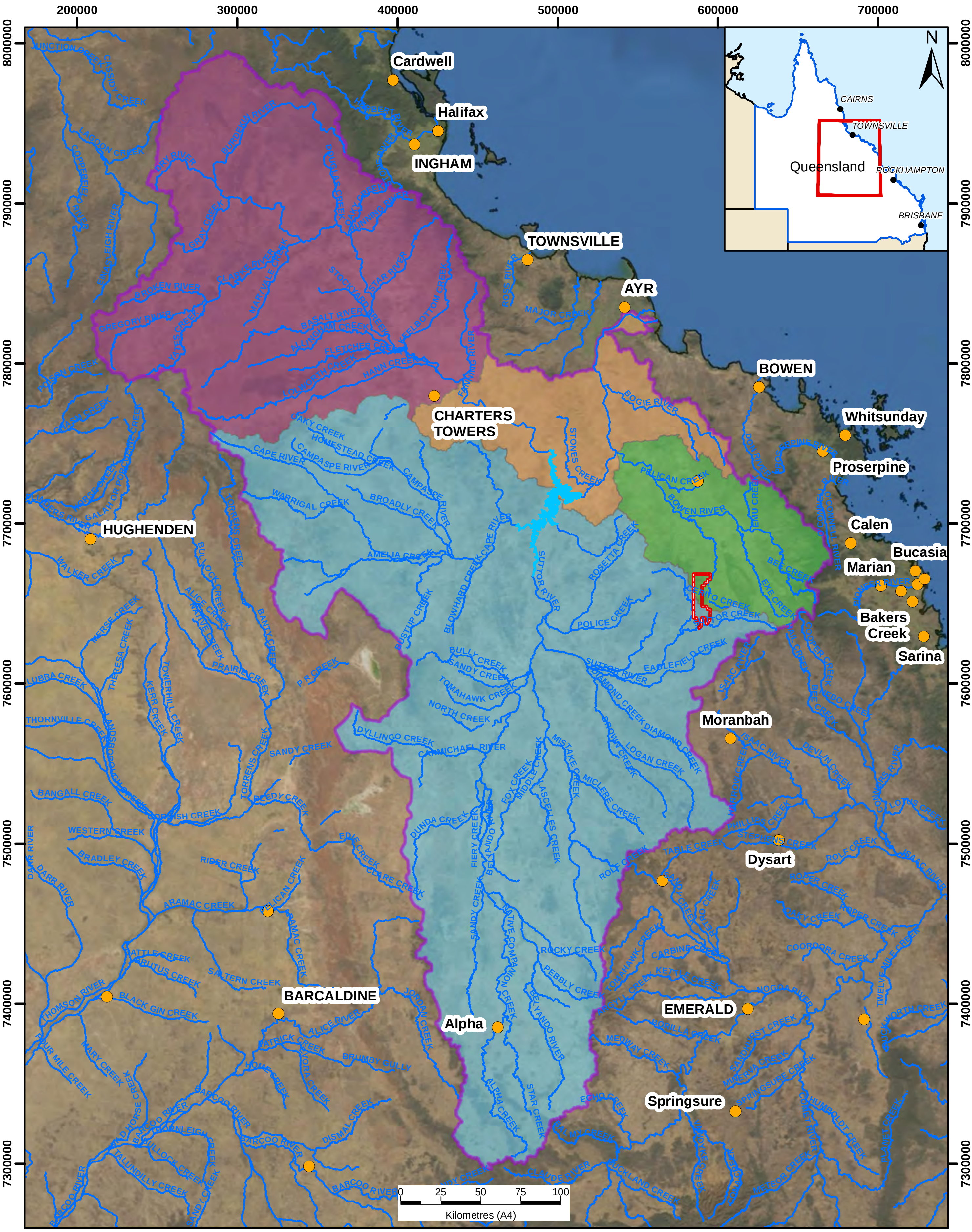
15.2.2 Hydrology and Topography

The project straddles the Suttor River and Bowen River catchment boundary, which are both part of the headwaters of the Burdekin River catchment (**Figure 15-1**).

The various catchment and sub-catchment relationships are as follows:

- Burdekin River catchment:
  - Bowen River catchment:
    - Rosella Creek sub-catchment, covering the northern extent of the project area and contains Kangaroo Creek (refer to **Figure 15-2)**.
  - Suttor catchment:
    - Upper Suttor River sub-catchment, covering the southern extent of the project area and contains the Suttor River and Suttor Creek (refer to **Figure 15-3)**.

Waterways within the catchment vary between largely sandy, ephemeral creek systems to permanently flowing clear-water rivers and creeks.



Legend

- Project Area
- Burdekin Falls Dam
- Burdekin Basin Catchment
- Major Watercourses
- Towns
- Bowen River Basin
- Lower Burdekin River Basin
- Suttor River Basin
- Upper Burdekin River Basin

Burdekin Basin Catchment		QCOAL GROUP
Figure 15-1	Byerwen Coal Project	environmental and licensing professionals pty ltd
Date: 29/01/2013	**Author:** samuel.ferguson **Map Scale:** 1:3,100,000	
Revision: R1	**Coordinate System:** GDA 1994 MGA Zone 55	
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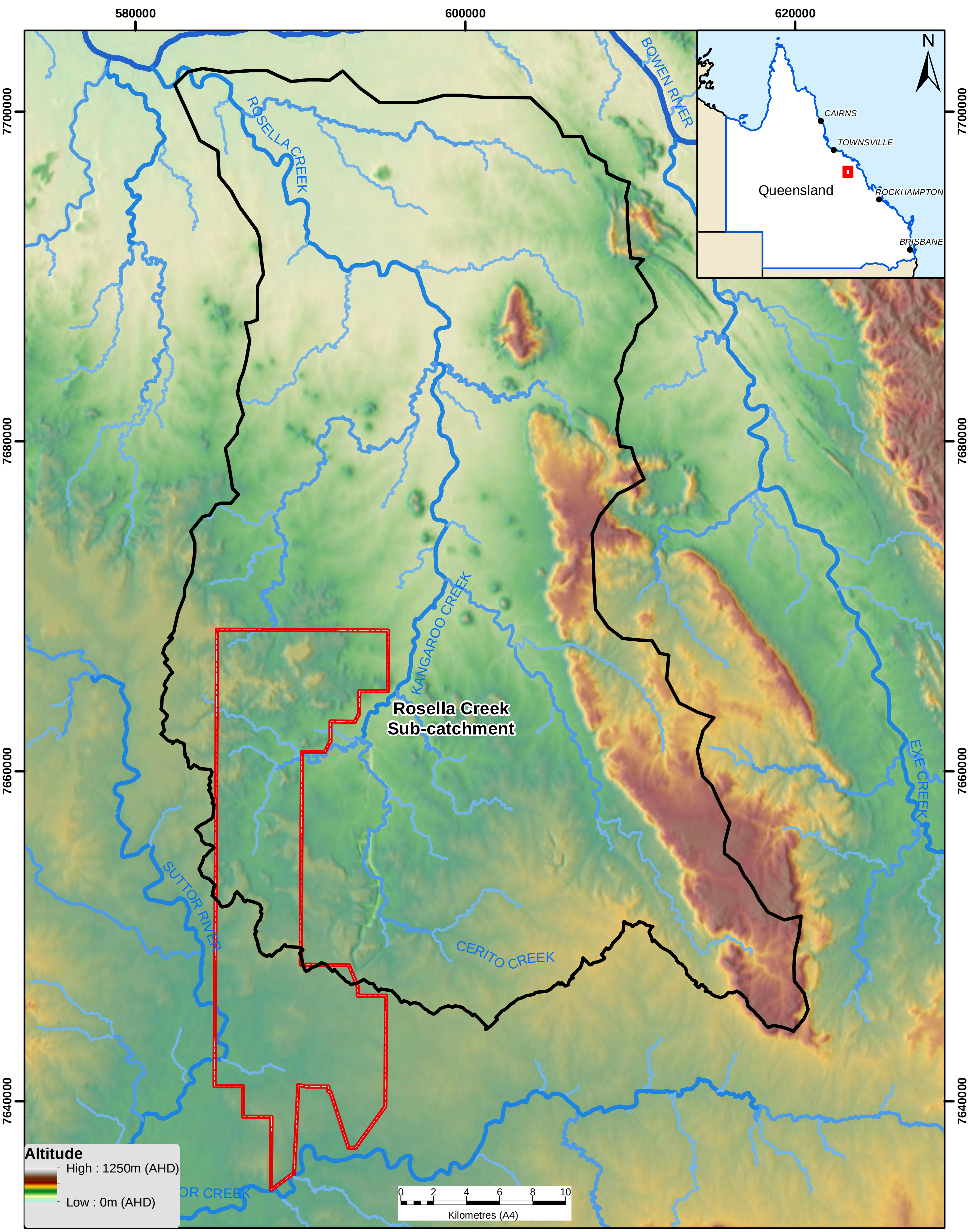

Legend

- Project Area
- River Subcatchments

Drainage (Stream Order)

3 4 5 6

Rosella Creek Sub-Catchment	
Figure 15-2	**Byerwen Coal Project**
Date: *29/01/2013*	**Author:** samuel.ferguson
	Map Scale: 1:300,000
Revision: R1	**Coordinate System:** GDA 1994 MGA Zone 55

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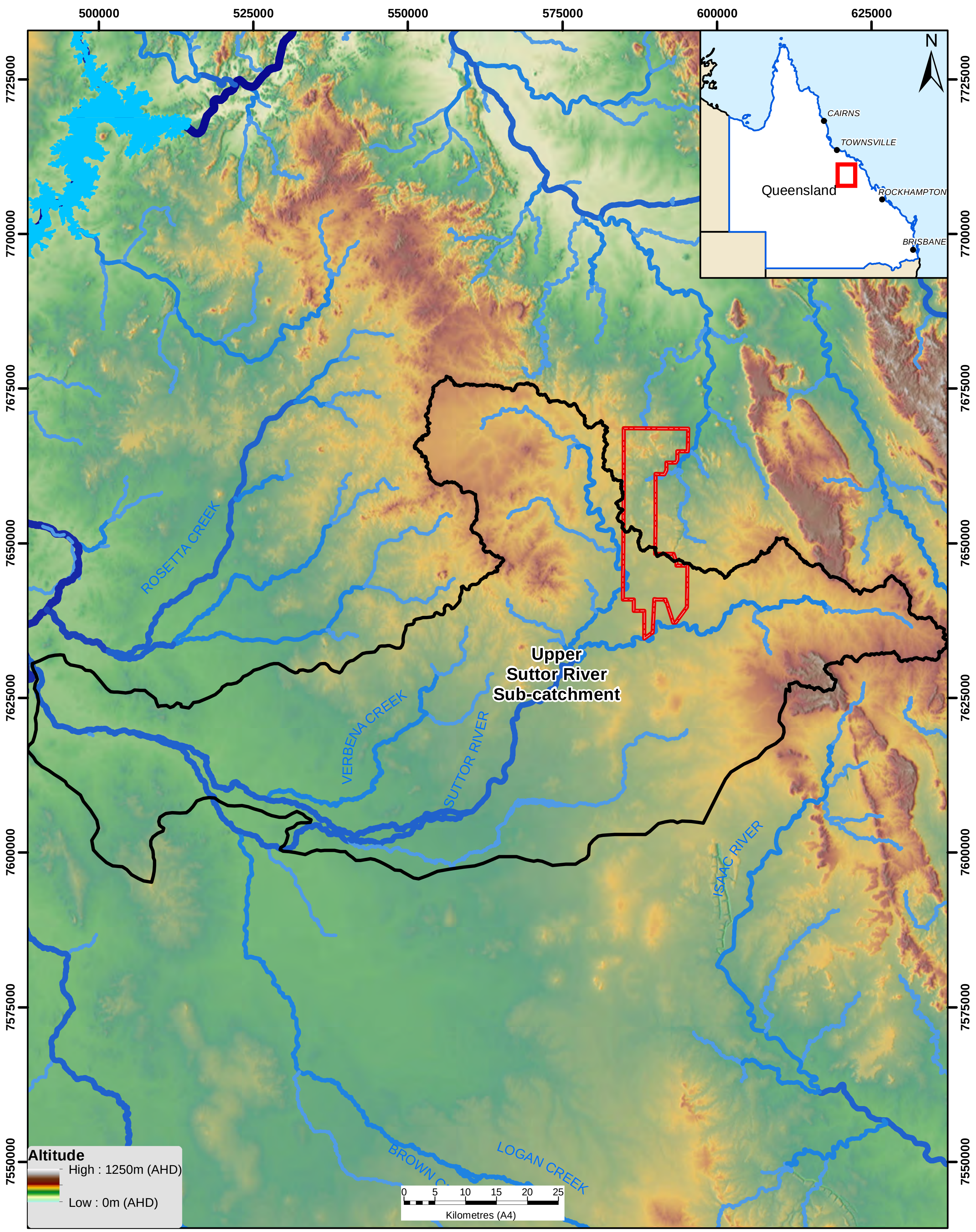

Legend

- Project Area
- River Subcatchments
- Burdekin Falls Dam

Drainage (Stream Order)

4 5 6 7 8 9

Upper Suttor River Sub-Catchment	
Figure 15-3	**Byerwen Coal Project**
Date: *29/01/2013*	**Author:** samuel.ferguson
	Map Scale: 1:800,000
Revision: R1	**Coordinate System:** GDA 1994 MGA Zone 55

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The Burdekin Falls Dam is described in the Queensland Wetland mapping data as a lacustrine wetland (see **Section 15.2.6**). There are two weirs downstream of the dam, (Blue Valley Weir and Clare Weir). The Burdekin River discharges to the Pacific Ocean near Ayr.

Within the Bowen and Suttor River catchments are the 1,473 km^2 Rosella Creek sub-catchment (part of the Bowen River catchment) to the north and the 5,155 km^2 Upper Suttor River sub-catchment (part of the Suttor River catchment) to the south.

15.2.3 Watercourse Characteristics

15.2.3.1 Rosella Creek Sub-catchment

The project area encompasses ninety five riverine systems or drainage lines mapped by EHP within the sub-catchment. These include:

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

Kangaroo Creek is located in the upper reaches of the Rosella Creek sub-catchment. Kangaroo Creek becomes Rosella Creek downstream of the project boundary (refer to **Figure 15-2**). 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. Sections of the upper reaches accessed in September 2012 consisted of a series of pools while closer to the north eastern edge of the project area, recessional baseflows were encountered. Photos of Kangaroo Creek at the locations shown in **Figure 15-4** are presented in **Photo 15-1**, **Photo 15-2**, and **Photo 15-3**.

Rosella Creek is a largely sandy, dry seasonal creek system with limited habitat availability, although waterholes are present that create aquatic habitat in places ((Burdekin Water Quality Improvement Plan 2009 (Dight, 2009)). Rosella Creek flows generally north and discharges into the Bowen River.

15.2.3.2 Upper Suttor River Sub-catchment

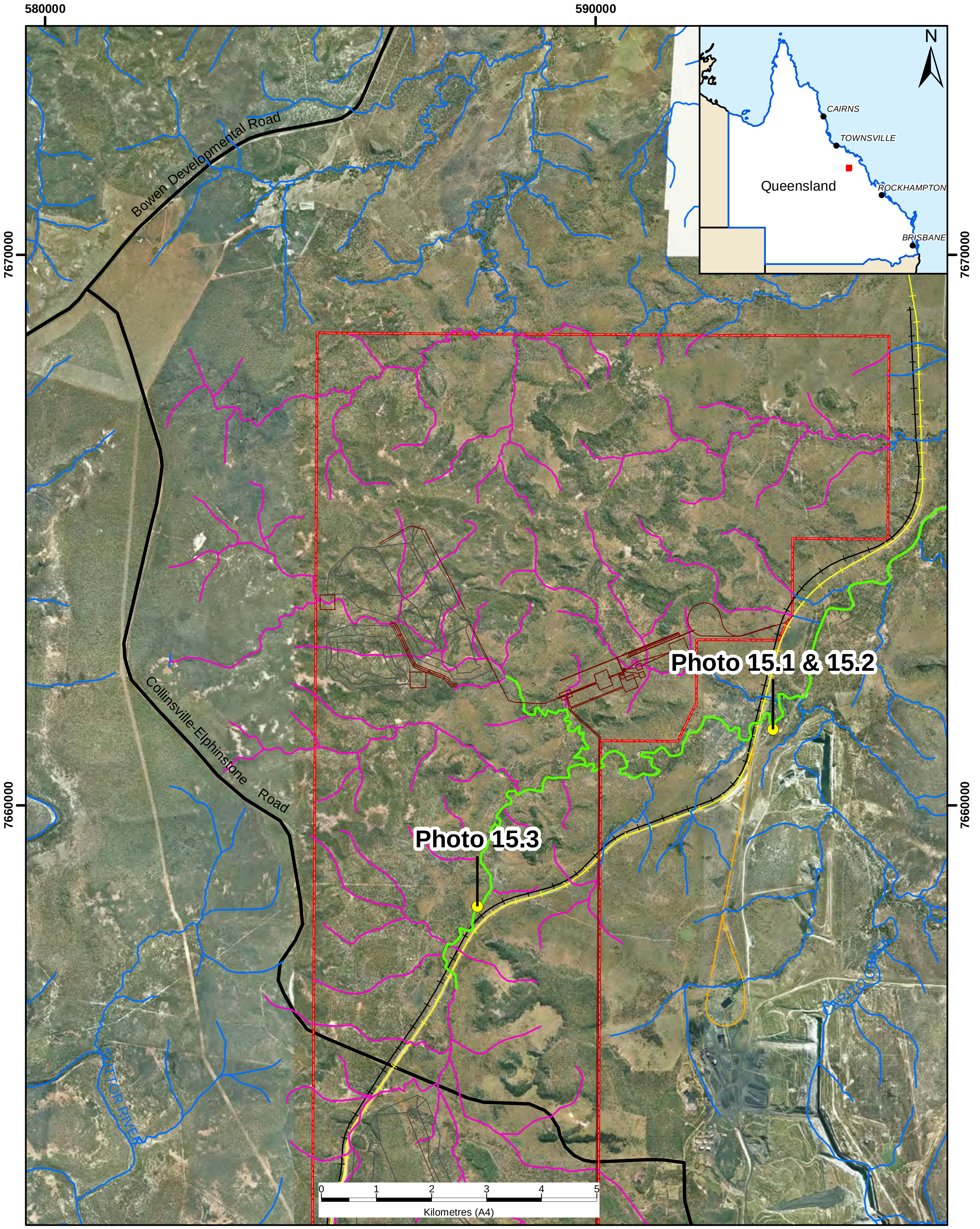
Within the Upper Suttor River sub-catchment, the project area encompasses 15 riverine systems or drainage lines comprising:

- 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 (refer to **Figure 15-5)** consists of a large sandy, meandering watercourse. The river is ephemeral, with flow recorded at Eaglefield gauging station (25km downstream of the project area) less than 40% of the time.

Recessional baseflows linking a series of pools were encountered during a site visit in September 2012 and are shown in **Photo 15-4** and **Photo 15-5** (locations of photos shown in **Figure 15-5**). The bed and banks of the river are sharply defined.

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



Legend

- Project Area
- Mine Infrastructure
- GAP Railway
- Newlands Mine Rail Loop
- Alpha Coal Project Rail Line
- Waste Rock Dumps and Pits
- Formed Roads
- Watercourse under Water Act 2000
- Not a Watercourse under Water Act 2000
- Waterway status not assessed
- Photopoint

Watercourses within the Northern part of the Project Area		QCOAL GROUP
Figure 15-4	**Byerwen Coal Project**	elp environmental and licensing professionals pty ltd
Date: 1/03/2013	Author: samuel.ferguson Map Scale: 1:90,000	
Revision: R1	Coordinate System: GDA 1994 MGA Zone 55	

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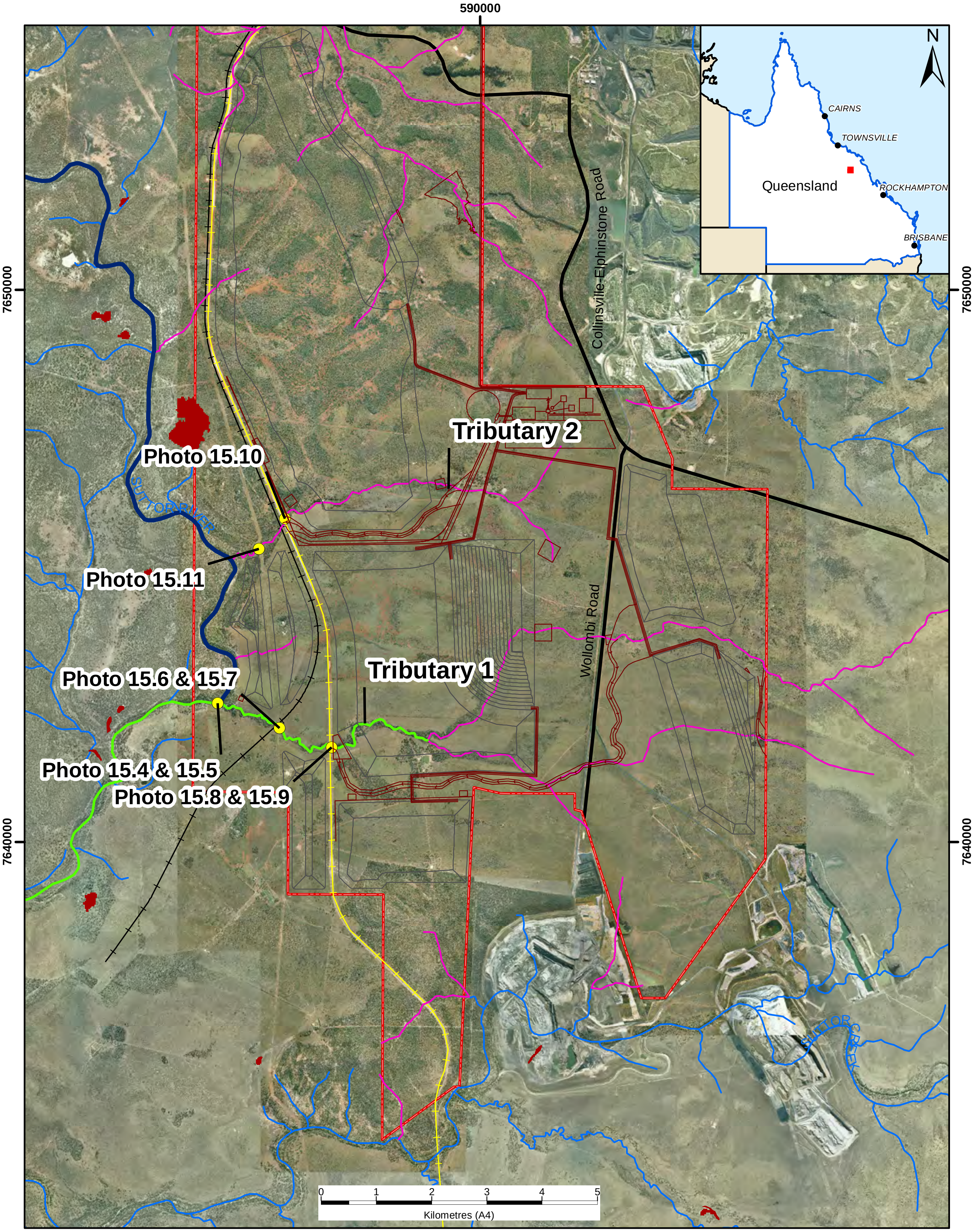

Legend

- Project Area
- Mine Infrastructure
- Waste Rock Dumps and Pits
- GAP Railway
- Newlands Mine Rail Loop
- Alpha Coal Project Rail Line
- Formed Roads
- Watercourse under Water Act 2000
- Not a Watercourse under Water Act 2000
- Suttor River
- Waterway status not assessed
- Palustrine Water Body
- Photopoint

Watercourses within the Southern part of the Project Area

Figure 15-5

Byerwen Coal Project

QCOAL GROUP

environmental and licensing professionals pty ltd

Date: *1/03/2013*

Author: samuel.ferguson

Map Scale: 1:90,000

Revision: R1

Coordinate System: GDA 1994 MGA Zone 55

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15.2.4 Watercourse Determinations

An EHP letter of advice (19 July 2012), advised that within the project boundary,- two watercourses met the watercourse determination criteria of the *Water Act* 2000, one in Rosella Creek sub catchment and one in Upper Suttor River sub catchment.

15.2.4.1 Rosella Creek Sub catchment

Identified watercourses are sections of Kangaroo Creek and a tributary of Kangaroo Creek shown in **Figure 15-4** (Rosella Creek sub catchment).

15.2.4.2 Upper Suttor River Sub catchment

EHP advised that within the project area a section of a single tributary of the Suttor River meets the *Water Act* 2000 criteria and is labelled 'Tributary 1' on **Photo 15-6** and **Photo 15-7** and flows from east to west across the southern section of the project area.

Tributary 1 was accessed at two locations on 26 September 2012 and is shown in **Photo 15-6** to **Photo 15-9** (locations shown in **Figure 15-5).** 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' (shown in **Photo 15-10** and **Photo 15-11)** can be described as a dry, sandy, ephemeral drainage line. The banks and low flow channel are poorly defined.

15.2.5 Land Use

15.2.5.1 Rosella Creek Sub-catchment

The principal land use is grazing on native pastures. Due to long term grazing activities and extensive clearing of the floodplain, the condition of the waterways and riparian habitat has undergone major decline over the last 30 years (Dight, 2009).

Hill slope erosion is identified by the Burdekin WQIP 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 being mostly in fair condition, with roughly equal proportions of good and poor condition areas. Water quality has been predicted by the Burdekin WQIP technical panel to be relatively poor, with elevated concentrations of sediment leaving the sub-catchment.

15.2.5.2 Upper Suttor River Sub-catchment

Land use consists almost exclusively of grazing on natural and modified pastures. 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. 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.

Hill slope erosion is identified as the major source of sediment and particulate nutrients affecting water quality within the Suttor Basin. Gully erosion is also identified as a significant contributor. Water quality in the Suttor Basin is predicted to have moderately elevated suspended sediment concentrations and loads at end-of-basin during wet season event flows (NQ Dry Tropics, 2009).

15.2.6 Wetlands

A review of Queensland Wetland Mapping data compiled by EHP indicated that there are no wetlands of international significance (Ramsar Convention) in the project area or anywhere upstream of the Burdekin Falls Dam. The Burdekin Falls Dam is described in the Queensland Wetland Mapping data as a lacustrine wetland. The water body is an artificial and highly modified wetland. While recognised as a wetland by the EHP, its ecosystem value is diminished because it is artificial and is operated for flood mitigation and irrigation/drinking water supply purposes.

Four lacustrine wetlands and a single palustrine wetland area are identified within or immediately adjacent to the project footprint (detail of the ecological values of these wetlands is provided in **Chapter 19**).

15.2.6.1 Palustrine Wetland

The palustrine wetland is situated on a closed depression of the Suttor River floodplain, and is intersected by the western boundary of the project area (see **Figure 15-5**). At the time of surveys conducted as part of the aquatic ecology assessment in May 2012, this wetland was identified as a vegetated swamp covering approximately 60 ha (1 km x 0.6 km), with an average depth of 0.5 m. The palustrine wetland will be retained, and is not within the footprint of the project.

The pre-development inundation extents for the 1, 2 and 5 year Average Recurrence Interval (ARI) flood events show that the palustrine wetland is not inundated during these more frequent flood events. This indicates that flooding from the Suttor River is not the main source of water for the wetland.

15.2.6.2 Lacustrine Wetlands

The Queensland Wetlands Mapping identifies four mapped lacustrine wetlands within the project area. Three of these are dammed drainage channels, and the fourth is a topographic depression on the upslope of a constructed contour in the south-eastern section of the project area, (see **Figure 15-5).**

One of the dams is positioned within the footprint of West Pit 1, and would be dewatered as part of the project. This dam was enlarged in 2011. At the time of the aquatic ecology assessment surveys, the wetted area of site was approximately 5 ha, being approximately 250 m wide at the dam wall, and extending approximately 400 m upstream.

The second dam is approximately 0.8 ha in area and is in the path of the drainage diversion between South Pit 1 and South Pit 2, and thus would need to be removed as part of diversion construction works.

Photo 15-1 Kangaroo Creek Looking Upstream of Cerito Road Crossing

Photo 15-2 Recessional Baseflows in Kangaroo Creek Looking Downstream of Cerito Road Crossing

Photo 15-3 Cobbled Section in Upper Reaches of Kangaroo Creek Looking Upstream

Photo 15-4 Suttor River at Mining Lease Western Boundary Looking Downstream

Photo 15-5 Suttor River at Mining Lease Western Boundary Looking Upstream

Photo 15-6 Tributary 1 Approximately 1 km from Suttor River Looking Downstream

Photo 15-7 Tributary 1 Approximately 1 km from Suttor River Looking Upstream

Photo 15-8 Tributary 1 at Northern Missing Link Railway Line Crossing Looking Downstream

Photo 15-9 Tributary 1 at Northern Missing Link Railway Line Crossing Looking Upstream

Photo 15-10 Tributary 2 at Northern Missing Link Railway Line Crossing Looking Upstream

Photo 15-11 Tributary 2 Approximately 0.6 km Upstream of Suttor River Looking Downstream

15.3 Environmental Values

Under the EPP (Water), the protection of the receiving environment is guided by the identification of EVs relating to those waters. EVs require protection from the effects of pollution, waste discharge and modified sediment processes.

There are no EVs established for the Burdekin Basin Catchment, as per Schedule 1 of the EPP (Water). EVs adopted for the receiving waterways have therefore been identified based on a review of land uses and downstream water usage patterns within the relevant sub catchments.

The Burdekin WQIP presents a qualitative assessment of the sub-catchments which was also referenced. The EVs for each of the two sub-catchments are described within **Table 15-1** and discussed below.

15.3.1 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 as follows:

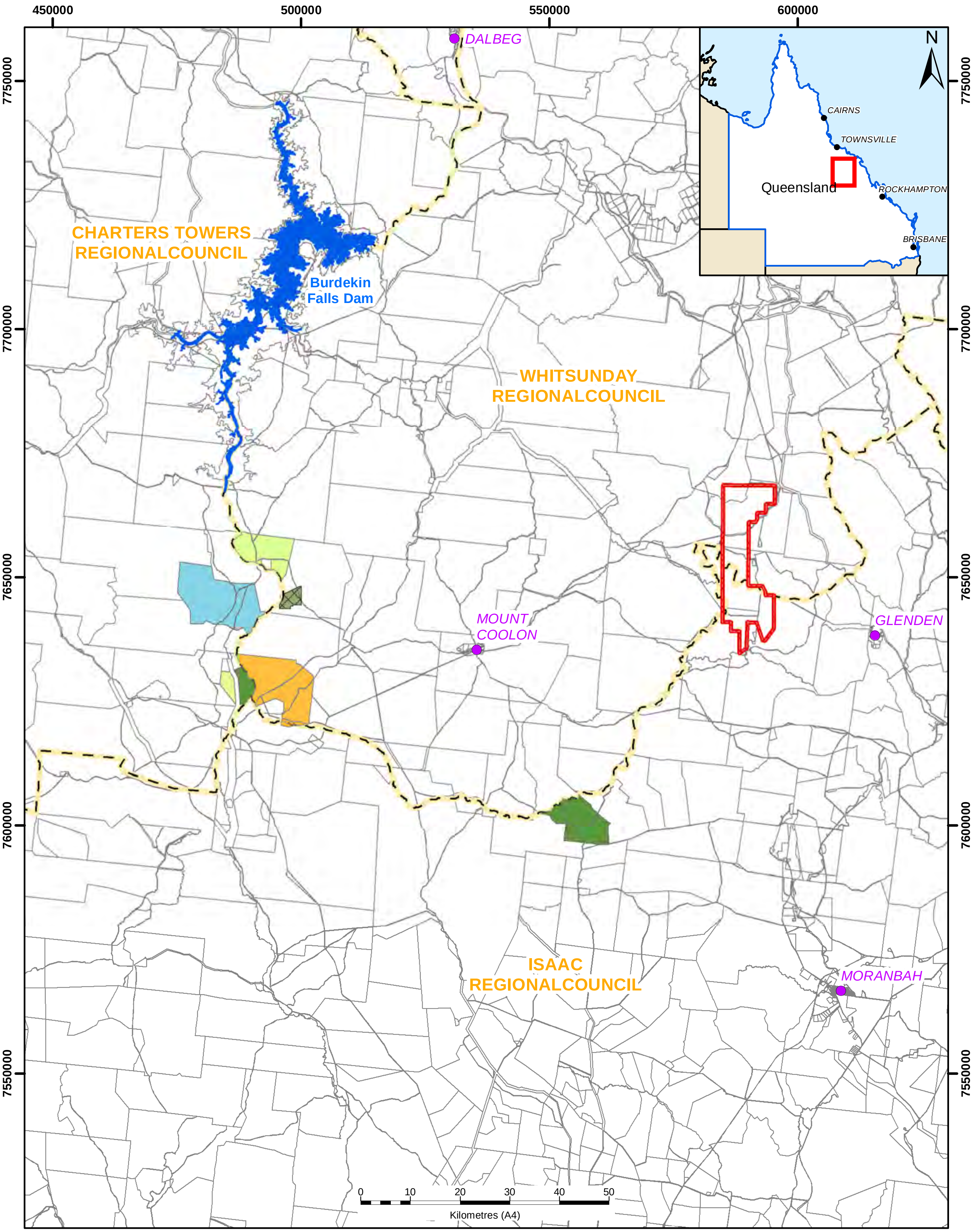
- High Ecological Value (HEV) ecosystems –essentially unmodified, highly valued aquatic ecosystems in which the ecological integrity is regarded as intact.
- Slightly to Moderately Disturbed (SMD) ecosystems – ecosystems in which aquatic biodiversity may have been diminished to a small but measurable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

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

Table 15-1 Environmental Values for the Burdekin Catchment

Draft Environmental Value	Rosella Creek Sub-catchment	Upper Suttor River Sub-catchment
Protection of aquatic ecosystems	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 slight to moderately disturbed as a consequence of the surrounding land use for cattle grazing.	The Suttor River and its tributaries are ephemeral streams which can occasionally contain large waterholes. The size and persistence of these waterholes is dependent on the substrate composition, season and climatic conditions. The sub-catchment's physical attributes, water quality and the composition of aquatic floral and faunal communities will therefore be highly variable over time. The catchment area shows pre-existing dry land salinity which is likely to result from erosion caused by a combination of natural and anthropogenic processes. This may cause a potential threat to aquatic ecosystems within the catchment. The Burdekin WQIP technical panel indicate that macroinvertebrates have experienced moderate change along the Suttor River. Fish and water quality are moderately affected below the junction with the Belyando River. Two lacustrine wetlands and one palustrine wetland area are located within or immediately adjacent to the project footprint. 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 Hydrology and Hydraulics (**Chapter 16**) and Aquatic Ecology (**Chapter 20**) chapters respectively.
Suitability for 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.	Land use is predominantly grazing on natural and modified pastures. Livestock water supply is commonly extracted from the surrounding water resources.

Draft Environmental Value	Rosella Creek Sub-catchment	Upper Suttor River Sub-catchment
Suitability for industrial uses	Mining has a presence within this catchment and further development is planned. Specifically, Xstrata's Newlands, Newlands East, Northern Underground mines and Eastern Creek (North and South) mines are located immediately to the east of the project. It is likely that this area of mining activity will be extended within the life of the project.	Coal mining activities are undertaken within this catchment and further development is planned. Xstrata's Suttor Creek mine (containing the Wollombi and Suttor Creek Pits) exist adjacent to the southern boundary of the project.
Cultural and spiritual values (refer to **Chapter 28 and 29**).	The Birriah and Jangga traditional owners have custodial use of water resources within the catchments. Environmental values: ▪ water access and use ▪ water allocation for traditional owners ▪ water to camp near for traditional activities ▪ participation in the management of water.	
Suitability for primary and secondary and visual recreation	None identified	Swimming, fishing and camping along the Suttor River.
Suitability for drinking water and human consumption	None identified	Drinking water is cited as an environmental value in the Burdekin WQIP. There are 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. The potential exists for river water to be used for drinking purposes.
Suitability for irrigation and protection of water harvesting entitlements	None identified	**Figure 15-6** shows existing licences to impound, divert or take water (within approximately 100km of the project site). 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.



Legend

- Project Area
- Local Government Boundary
- Cadastre

Licence to Interfere by Diversion

- Divert the course of flow

Licence to Interfere by Impounding - Embankment or Wall

- Impound Water

Licence to Take Water

- Rural
- Irrigation, Stock Intensive, Water harvesting
- Water harvesting
- Irrigation, Water harvesting

Water Licence Holders	
Figure 15-6	Byerwen Coal Project
Date: 6/02/2013	Author: samuel.ferguson
	Map Scale: 1:1,000,000
Revision: R1	Coordinate System: GDA 1994 MGA Zone 55

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15.4 Default Water Quality Guidelines

Water quality guidelines support and maintain the designated EVs of a particular water body. They form the basis for determining WQOs.

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

- ANZECC Guidelines –provide values (numbers) or descriptive statements for different indicators to protect aquatic ecosystems and human uses of waters. 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) tailored to Queensland regions and water types
  - providing a process for deriving and applying locally specific guidelines for waters.
- EPP (Water) – EVs and WQOs have been scheduled under the EPP (Water) for certain waters within Queensland.

The EPP (Water) describes the method for applying the water quality guidelines. 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.

Currently no EV's or WQO's 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. These guidelines revert to the ANZECC guidelines for certain water quality parameters.

For freshwaters, the QWQG generally defaults to the ANZECC guidelines categories of upland and lowland freshwaters. The ANZECC Guidelines suggest a cut-off of 150 m elevation to differentiate between lowland and upland freshwaters but also acknowledges 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 greater than 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.

15.5 Local Water Quality Assessment

Water chemistry data was analysed for the respective catchments. Water quality indicators have been used to establish the management measures to protect the identified EVs.

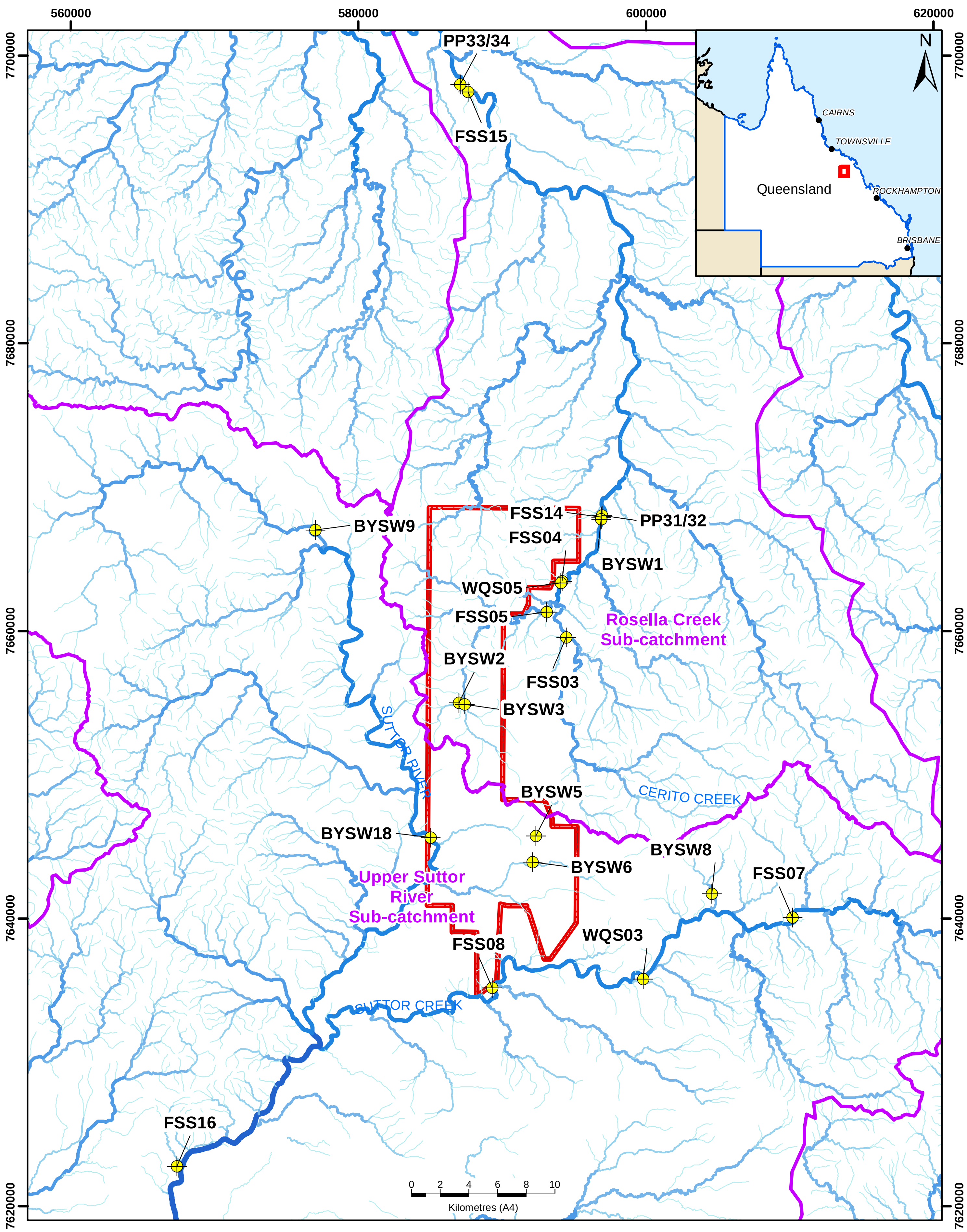
Data was sourced from surface water monitoring within the Rosella Creek and Upper Suttor River sub-catchments on and around the project area by the proponent from 2010 to 2012.

The dataset was supplemented using similar data generated by Xstrata Coal Pty Ltd for the adjacent Newlands Coal mine between 2006 to 2011 via a data-share agreement between the proponent and Xstrata.

The compiled dataset is shown in **Table 15-2**. Locations of monitoring sites are shown on **Figure 15-7**.

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. 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.

During a site visit on 26 September 2012, a series of water quality field measurements were taken within and immediately adjacent to the project area and were considered in conjunction with the longer term water quality data set as part of the overall analysis of existing water quality, as were the results of field tests and a one-off water quality sampling event undertaken as part of the aquatic ecology survey (refer to **Appendix 19**) during a site visit between 1 and 6 May 2012.



Legend

Project Area
River Subcatchments
Surface Water Sampling Sites

Drainage (Stream Order)

1 2 3 4 5 6

Surface Water Monitoring Locations	QCOAL GROUP
Figure 15-7	**Byerwen Coal Project**
***Date:* 29/01/2013**	**Author:** samuel.ferguson
	Map Scale: 1:341,944
Revision: R1	**Coordinate System:** GDA 1994 MGA Zone 55

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Table 15-2 Summary of Water Quality Monitoring Sites

Data Source	Site	Sub-Catchment	Period	Number of Observations
Monitoring data provided by the proponent and collected in surveys	BYSW1	Rosella	Apr 2012	2
	BYSW2	Rosella	Dec 2010 - Apr 2012	15
	BYSW3	Rosella	Dec 2010 - May 2011	11
	BYSW5	Suttor	Dec 2010 - May 2011	9
	BYSW6	Suttor	Dec 2010 - Apr 2012	14
	BYSW8	Suttor	Dec 2010 - Mar 2012	11
	BYSW9	Suttor	Mar 2012 - Apr 2012	5
	BYSW18	Suttor	Mar 2012 - May 2012	2
Data provided by Xstrata.	PP32	Rosella	Jan 2010 – Apr 2011	6
	PP33	Rosella	Jan 2007 - Apr 2011	10
	PP34	Rosella	Jan 2008 - Apr 2011	7
	FSS03	Rosella	Dec 2007 – Sep 2011	46
	FSS04	Rosella	Dec 2006 - Oct 2011	211
	FSS05*	**Rosella**	**Feb 2007- Sep 2011**	**84**
	FSS07**	**Suttor**	**Nov 2006 – Sep 2011**	**66**
	FSS08	Suttor	Jun 2006 - Aug 2011	303
	FSS14	Rosella	Dec 2010 - Sep 2011	149
	FSS15	Rosella	Dec 2010 - Sep 2011	173
	FSS16	Suttor	Jan 2007 - Aug 2011	32

Data Source	Site	Sub-Catchment	Period	Number of Observations
	WQS03	Suttor	Nov 2010 – Jan 2011	7
	WQS05	Rosella	Feb 2010 - Oct 2010	21

Notes:
*Selected as the monitoring location for Rosella Sub-catchment.
**Selected as the monitoring location for Suttor Sub-catchment.

15.5.1 Rosella Sub-catchment

A summary of monitoring data for the Rosella sub-catchments (median values and 80th percentile) is presented in **Table 15-3** and **Table 15-4** respectively. **Table 15-3** and **Table 15-4** also provide the default water quality objectives (refer **Section 15.4**) for waterways in the project catchment area. A summary of the full set of raw water quality monitoring data used for this assessment is contained within **Appendix 16** showing monitoring data by sampling location in the context of minimum, maximum and median values as well as the 20th and 80th percentiles. A discussion of the key water quality indicators is provided below.

15.5.1.1 Electrical Conductivity

The electrical conductivity (EC) data collected at all sites covers dates between February 2006 and April 2012. Median EC ranged from 2,071 µS/cm to 177 µS/cm. The 80th percentile EC exceeded 3,000 µS/cm in some areas, indicating that contrary to the 75th percentile QWQG relatively low level EC (271 µS/cm) in the broader Suttor-Belyando Rivers, the waterways in the project area have an existing, elevated salinity. A large degree of variation was noted for EC during periods of heavy rainfall, 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.

15.5.1.2 pH

Existing conditions in the study area for upland waterways consistently exceed the QWQG indicative median pH range (6.5 to 7.5 for flow periods), with typical pH values of between 8.0 and 8.5. This is consistent with the nature of the soils within the catchment. The results for the lowland streams also consistently exceed the guideline values. Regardless of the flow conditions, none of the median or 80th percentile pH values exceeded the QWQG values (ranging between 5.5 and 9.0) for flood events or periods of no flow.

15.5.1.3 Turbidity

The QWQG indicate that turbidity should be less than 25 Nephelometric Turbidity Units (NTU) for upland rivers and less than 50 NTU for lowland streams. Monitoring results indicate that existing conditions often exceed these values. Only two sites site (FSS05 and BYSW1) noted an 80th percentile value below the guidelines. Median values of up to 340 NTU were recorded in the Rosella Creek sub-catchment. Typical ephemeral waterway characteristics are evident with an assessment of seasonal variation showing increases in the range of turbidity during the wet months. Rosella Creek sub-catchment is subject to hill slope erosion and waterway bank erosion which contribute to turbidity levels, particularly during high flow periods, potentially as a consequence of cattle grazing.

15.5.1.4 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.

15.5.1.5 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 (80th percentile) aluminium occurs 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.

These high concentrations are attributable 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.

Bioavailability of heavy metals is also affected by the hardness of water. Guideline trigger values for copper, nickel and zinc require a site specific correction for hardness. Rosella Creek sub-catchment is characterised by 'hard' to 'extremely hard' water values and when trigger values were corrected upwards according to hardness, the concentration of dissolved zinc was below the hardness corrected trigger values across the catchment. Copper was also consistently below the corrected trigger value.

Table 15-3 Summary Median Water Quality Data for Rosella Creek Sub-catchment

Parameter	Units	(QWQG) 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	0.010	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**	0.01	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														

Parameter	Units	(QWQG) Default Trigger Level* (lowland/upland)	BYSW1	BYSW2^	BYSW3^	PP32	PP33	PP34	FSS03^	FSS04	FSS05	FSS14	FSS15	WQS05
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 15.4**

^ Upland stream

Table 15-4 Summary 80th Percentile Water Quality Data for Rosella Creek Sub-catchment

Parameter	Units	(QWQG) 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**	**8.67**	**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**	0.1	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**

Parameter	Units	(QWQG) Default Trigger Level* (lowland/ upland)	BYSW1	BYSW2^	BYSW3^	PP32	PP33	PP34	FSS03^	FSS04	FSS05	FSS14	FSS15	WQS05
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 15.4**

^ Upland stream

15.5.2 Upper Suttor River Sub-catchment

Baseline water quality monitoring data for the Upper Suttor River sub-catchments (median values and 80th percentile) is summarised in **Table 15-5** and **Table 15-6**, which also provide the default water quality objectives (refer **Section 15.4**) for waterways in the project catchment area. See **Appendix 16** for the full dataset.

15.5.2.1 Electrical Conductivity

Data 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 EC at most sites exceeded this criteria however large ranges were recorded (approximately 100 µS/cm to in excess of 800 µS/cm), suggesting that waterways have an existing elevated salinity. 80th percentile values exceeded the guideline value at all sites except one (WQS03).

15.5.2.2 pH

The QWQG indicate that during periods 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 indicate that pH levels consistently exceed this range, with typical pH values between 8.0 and 8.5 at most sites. This finding is consistent with the nature of the soils within the region.

The QWQG state that pH during flood events and periods of no flow should range between 5.5 and 9.0. Regardless of the flow conditions, none of the median or 80th percentile pH values exceeded the QWQG values for flood events or periods of no flow.

15.5.2.3 Sulfate

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

15.5.2.4 Turbidity

Median values for turbidity were in the range of 20 - 280 NTU. The QWQG state that turbidity in upland rivers should not exceed 25 NTU and lowland rivers should not exceed 50 NTU, which the monitoring data consistently did.

15.5.2.5 Metals Summary

The Upper Suttor River sub-catchment contains naturally high background aluminium concentrations. Background copper concentrations were also 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 high metal concentrations through mobilisation by erosion during flow events.

The sub-catchment is characterised by ‘soft’ to ‘moderate’ water values, with the exception of Suttor Creek where 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.

For further details of this analysis refer to **Appendix 16**.

Table 15-5 Summary Median Water Quality Data for Upper Suttor River Sub-catchment

Parameter	Units	(QWQG) Default Trigger Level* (lowland/upland)	BYSW5^	BYSW6^	BYSW8^	BYSW9	BYSW18	FSS07	FSS08	FSS16	WQS03	WQS04
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**	7.7
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	206
Turbidity (lab)	NTU	50 / 25	**80**	**45**	**55**	**266**	**584**	**87**	**70**	16	-	80
Oxidised Nitrogen	mg/L	0.06 / 0.015	**0.025**	0.010	0.010	**0.080**	0.05	-	-	-	-	0.025
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	0.90
Total Phosphorus	mg/L	0.05 / 0.03	**0.14**	**0.15**	**0.04**	-	-	-	-	-		0.14
Sulfate (dissolved)	mg/L	250	2	2	5	5	4	5	52	18	4	2
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**	0.100
Boron	mg/L	0.37	0.05	0.05	0.06	0.06	0.05	0.10	0.09	0.06	0.05	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**	0.0020
Manganese	mg/L	1.9	0.00	0.00	0.01	0.08	0.055	-	0.0	0.0	-	0.00
Nickel	mg/L	0.011	0.006	0.006	0.002	0.001	0.002	0.001	0.002	0.002	0.001	0.006
Zinc	mg/L	0.008	0.005	**0.009**	0.005	**0.012**	0.006	0.005	0.005	0.005	0.005	0.005

Parameter	Units	(QWQG) Default Trigger Level* (lowland/upland)	BYSW5^	BYSW6^	BYSW8^	BYSW9	BYSW18	FSS07	FSS08	FSS16	WQS03	WQS04
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	1.90
Boron	mg/L	n/a	0.05	0.05	0.06	0.06	0.05	0.10	0.09	0.06	0.05	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	0.007
Manganese	mg/L	n/a	0.14	0.02	0.04	0.14	0.160	-	0.1	0.3	-	0.14
Nickel	mg/L	n/a	0.014	0.008	0.003	0.003	0.005	0.003	0.005	0.003	0.007	0.014
Zinc	mg/L	n/a	0.009	0.015	0.006	0.006	0.014	0.009	0.006	0.007	0.011	0.009

Values in **RED** indicates an exceedance of default trigger value
* See **Section 15.4**
^ Upland stream

Table 15-6 Summary 80th Percentile Water Quality Data for Upper Suttor River Sub-Catchment

Parameter	Units	(QWQG) Default Trigger Level* (lowland/upland)	BYSW5^	BYSW6^	BYSW8^	BYSW9	BYSW18	FSS07	FSS08	FSS16	WQS03
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**	**0.238**	**0.120**	**1.292**	**0.182**
Boron	mg/L	0.37	0.05	0.05	0.10	0.06	0.05	0.05	0.11	0.07	0.05
Copper	mg/L	0.0014	**0.0034**	**0.0030**	**0.0020**	**0.0020**	0.001	**0.0020**	**0.0020**	**0.0020**	**0.0030**
Manganese	mg/L	1.9	0.02	0.01	0.02	0.16	0.075	0.00	0.00	0.03	-
Nickel	mg/L	0.011	0.007	0.006	0.002	0.002	0.002	0.002	0.002	0.002	0.002
Zinc	mg/L	0.008	0.007	**0.013**	0.006	**0.012**	0.006	0.005	0.005	0.005	0.006

Parameter	Units	(QWQG) Default Trigger Level* (lowland/upland)	BYSW5^	BYSW6^	BYSW8^	BYSW9	BYSW18	FSS07	FSS08	FSS16	WQS03
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 15.4**

^ Upland stream

15.6 Water Quality Objectives

WQO's 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. Site-specific WQO's 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 Burdekin WQIP states that insufficient data is available from the Burdekin Dry Tropics NRM region to derive locally relevant WQO for freshwater ecosystems.

Consequently draft WQO were derived based on the QWQG and ANZECC guidelines discussed within **Section 15.4**, which includes derivation of site specific WQO's.

15.6.1 Framework for Establishing Site-Specific Water Quality Objectives

Many of the baseline water quality sampling locations show ambient surface water quality indicators exceed those stipulated in the relevant water quality guidelines (see **Section 15.4** and **Table 15-3, Table 15-4, Table 15-5**, and **Table 15-6**).

Since the water quality guidelines cannot be appropriately applied, 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.

15.6.2 Selected Reference Sites

The reference sites were selected to reflect the natural conditions in the area. The QWQG suggest the following selection criteria should be used:

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

15.6.2.1 Rosella Creek Sub-catchment Reference Site Selection: FSS05

Based on the QWQG selection criteria, FSS05, BYSW2 and BYSW3 were considered as potentially suitable for reference sites.

Potential impacts on water quality at these monitoring sites include clearing for agricultural purposes as well as previous mining exploration activities. However, the sites are located upstream of any discharge locations of Xstrata's existing Newlands mine and are considered to be representative of the natural conditions of the area.

FSS04 (with 211 sampling events) was rejected as a potential reference site on the basis that it is located downstream of discharge points of the Newlands mine.

BYSW2 and BYSW3 were considered suitable from a location point of view, however the dataset for these sites was smaller than FSS05 (with 15 and 11 sample events respectively).

FSS05 was selected as the most representative site with 84 sampling events undertaken over the full spectrum of seasons between February 2007 and September 2011.

15.6.2.2 Upper Suttor River Sub-catchment Reference Site Selection: FSS07

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.

Their location within catchments local to the proposed project (and feeding into same the Suttor Basin), means that water quality is representative of the local area. 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 reference site.

15.6.3 Determination of WQOs

The recommended approach for an SMD receiving environment is to base the guideline values on the 20th and 80th percentiles of the monitoring dataset. The dataset needs to contain more than 12 data points with 24 data points considered more appropriate.

Where the 80th percentile values exceeded default trigger values, the 80th percentile values have been adopted as the draft WQOs, otherwise default trigger values have been adopted.

Where there was considered to be insufficient data for a particular parameter at FSS05, data from BYSW2 were used instead (refer to footnote of **Table 15-7**). Similarly, where there was insufficient data for FSS07, data from BYSW6 was used (refer to footnote of **Table 15-8**).

15.6.3.1 Rosella Creek Sub-catchment - Reference Site FSS05

A comparison of the default trigger values and the 80th percentile for ambient surface water quality is shown in **Table 15-7**.

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 15-7 Comparison between Guideline Values and Ambient Surface Water for Site FSS05

Parameter	Units	Default Trigger Level	Reference Site				Draft WQO
			20th Percentile	Median	80th Percentile	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

Parameter	Units	Default Trigger Level	Reference Site				Draft WQO
			20th Percentile	Median	80th Percentile	n	Rosella Creek Sub-Catchment
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 15.4**
** During flow
^ Insufficient data
# Sourced from BYSW2
~ Hardness modified trigger value

15.6.3.2 Upper Suttor River Sub-catchment - Reference Site FSS07

A comparison of the default trigger values and the 80th percentile for ambient surface water quality is shown in **Table 15-8**.

Table 15-8 Comparison between Guideline Values and Ambient Surface Water for Site FSS07

Parameter	Units	Default Trigger Level	Reference Site				Draft WQO
			20th Percentile	Median	80th Percentile	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

Parameter	Units	Default Trigger Level	Reference Site				Draft WQO
			20th Percentile	Median	80th Percentile	n	Upper Suttor River Sub-Catchment
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~	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~	0.001	0.001	0.002	57	0.03
Zinc	mg/L	0.02~	0.005	0.005	0.007	57	0.02

Values in **RED** indicates an exceedance of default trigger value
* See **Section 15.4**
** During flow
^ Insufficient data
# Sourced from BYSW6
~ Hardness modified trigger value

15.6.4 Discussion of Water Quality Findings

For the majority of parameters, the WQO default trigger values have been retained as the draft WQOs. The exceptions to this are pH, electrical conductivity, turbidity, total nitrogen and aluminium. After reviewing the full set of baseline water quality data, as well as literature provided in the Burdekin WQIP, these parameters are higher compared to published guidelines 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 WQOs below (see **Table 15-9),** 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 draft WQO's will be used for setting release limits for mine affected water and sediment affected water applicable for the project. The draft WQO's for EC has been used in developing the release criteria for the mine water management strategy presented in **Chapter 8**.

Trigger investigation levels are identified for downstream compliance points. Trigger investigation values are values that if exceeded, trigger a requirement for 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. **Figure 15-8** shows the monitoring and compliance positions for the two catchments.

Table 15-9 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

Parameter	Units	Default Trigger Level		Draft WQO	
				Upper Suttor River Sub-Catchment	Rosella Creek Sub-Catchment
	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 15.4**.
^ Hardness modified trigger value, Upper Suttor River sub-catchment
# Hardness modified trigger value, Rosella Creek sub-catchment

15.7 Impacts and Mitigation Measures

Adherence to mitigation measures set out below is expected to protect the EV's and objectives identified for water quality within the sub-catchment areas.

15.7.1 Palustrine Wetland

Impacts on the hydrology of the palustrine wetland are described in **Chapter 16**. Impacts and mitigation on the aquatic ecology are described in **Chapter 19** (see also **Appendix 20**).

In summary the catchment supplying water to the palustrine wetland will be disrupted by construction of a waste rock dump associated with West Pit, reducing flow to the wetland. In the first year of mining the catchment will reduce from 4.2 km^2 to 2.9 km^2, and then there will be a further reduction from 2.9 km^2 to 2.4 km^2 around year 5. The wetland catchment will be reduced for a period of around 16 years.

In a median rainfall year the surface water flowing to the wetland would reduce from approximately 170 ML to 95 ML as a result of this catchment reduction, resulting in a shortfall of some 75 ML per annum over the 16 year disturbance period.

The remediation strategy for this part of the project involves returning the land to a similar hydrological profile, creating a similar catchment for the wetland. The area would be rehabilitated by around year 16, allowing the hydrological processes currently feeding the wetland to be reinstated.

15.7.2 Erosion and Sediment Mobilisation

Sediment mobilised during construction and operations has the potential to discharge to waterways leading to deleterious effects on water quality and aquatic habitats. Sediment exposed or generated during construction or operation may also be blown by wind into surface water bodies. Areas of disturbed soil will be managed to reduce sediment mobilisation or erosion by best practice management techniques.

An Erosion and Sediment Control Plan will be developed for the project. The key features in the Erosion and Sediment Control Plan will involve:

- concentrating work to as small an area as practicable to limit the amount of disturbed area exposed at any one time
- minimising the number of passes by heavy earth moving equipment when undertaking soil stripping activities
- implementing sediment limitation devices (e.g. sediment dams, drainage ditches) to restrict sediment movement off site
- constructing bunds to restrict flow velocities across the project area and therefore reducing scour of waterway bed and banks
- limiting vegetation clearing work during heavy rainfall
- adopting stormwater controls and upstream treatment, such as infiltration devices and vegetation filters
- revegetating and/or use of other stabilisation techniques, considering seasonal influences, upon completion of works
- minimising vegetation disturbance, especially riparian vegetation
- implementing dust suppression measures including irrigation, energy dissipation and scour protection measures such as matting, riprap and gabions.

Construction activities at or near drainage features can mobilise sediment and alter flow and quality characteristics. These potential impacts can be managed by:

- installing suitable stormwater management infrastructure prior to commencing construction activities
- minimising disturbance by earthmoving equipment, especially in riparian areas.

Where practicable, mitigation measures will be in alignment with the requirements and provisions of the Department of Natural Resources and Mine's (DNRM's) Guideline—*Activities in a watercourse, lake or spring associated with a resource activity or mining operations* (2012). Where this is not practicable a riverine protection permit will be sought (in accordance with section 269 of the *Water Act* 2000).

A riverine protection permit will be required to take or interfere with water in a defined watercourse (refer **Section 15.2.4**). This will occur at with the diversion of the watercourse associated with the diversion of Tributary 1 (associated with Diversion 2 between South Pit 1 and West Pit 1), the central infrastructure crossing of Kangaroo Creek and potentially a haul road crossing of a Kangaroo Creek tributary.

15.7.3 Contaminant Mobilisation

Potential sources of onsite water contaminants during mining are predominately diesel and other petroleum based fuel and lubricants used by excavation and construction machinery. Litter may also detrimentally impact water quality. There may be some minor releases through spills/accidents, but these will most likely occur in pits and be contained within the mine water management system.

The likelihood and the consequences of potential impacts will be mitigated by:

- the transfer of fuels and chemicals controlled and managed to prevent spills outside of bunded areas
- a management system that requires any significant spillage or leakage to be immediately reported and an appropriate emergency clean-up operation implemented to prevent possible mobilisation of contaminants.

15.7.4 Mine Water Management System

The mine water management system is described in **Chapter 8**. The impacts on surface water quality in receiving waters from the operation of the mine water management system in accordance with the release criteria specified in **Chapter 8** is described below.

15.7.4.1 Clean Water

In most cases runoff from undisturbed catchments upstream of the mining area would be diverted around the disturbed area and released directly to the environment. In some cases (West Pits 1 and 3, South Pit 1, North Pit 1), a clean water dam is proposed either to facilitate the diversion, or to provide a source of clean water that can be used to blend with mine affected water if required) to facilitate release.

Water quality of the clean water circuit would be typical of the existing waterways. The clean water circuit would flow to the receiving waterway when runoff occurs, except in situations where a dam is proposed.

15.7.4.2 Mine Affected Water

Mine affected water may not be suitable for direct release, likely due to elevated salinity and alkalinity.

Mine affected water would be contained on site in dams for periods of time until there is sufficient dilution to allow release to the environment and still achieve WQOs in receiving waters. This may be achieved either through dilution in the receiving environment, blending water within the mining area or a combination of these strategies.

15.7.4.3 Sediment Affected Water

Sediment affected water would pass through sedimentation dams prior to release to the environment, once the applicable sediment concentrations have been satisfied. If these sources also contain elevated salinity, then they would be reclassified as mine affected water and included in that water circuit.

15.7.5 Controlled Release Strategy

It will be necessary for the project to release water to the environment to balance the mine water inventory. This will be achieved through a controlled release strategy that allows discharge into waterways only when specific flow and water quality criteria have been satisfied.

A set of controlled release conditions for the project have been developed to suit the local catchments of the project area, in accordance with the guidelines and recommendations in the ANZECC and QWQG.

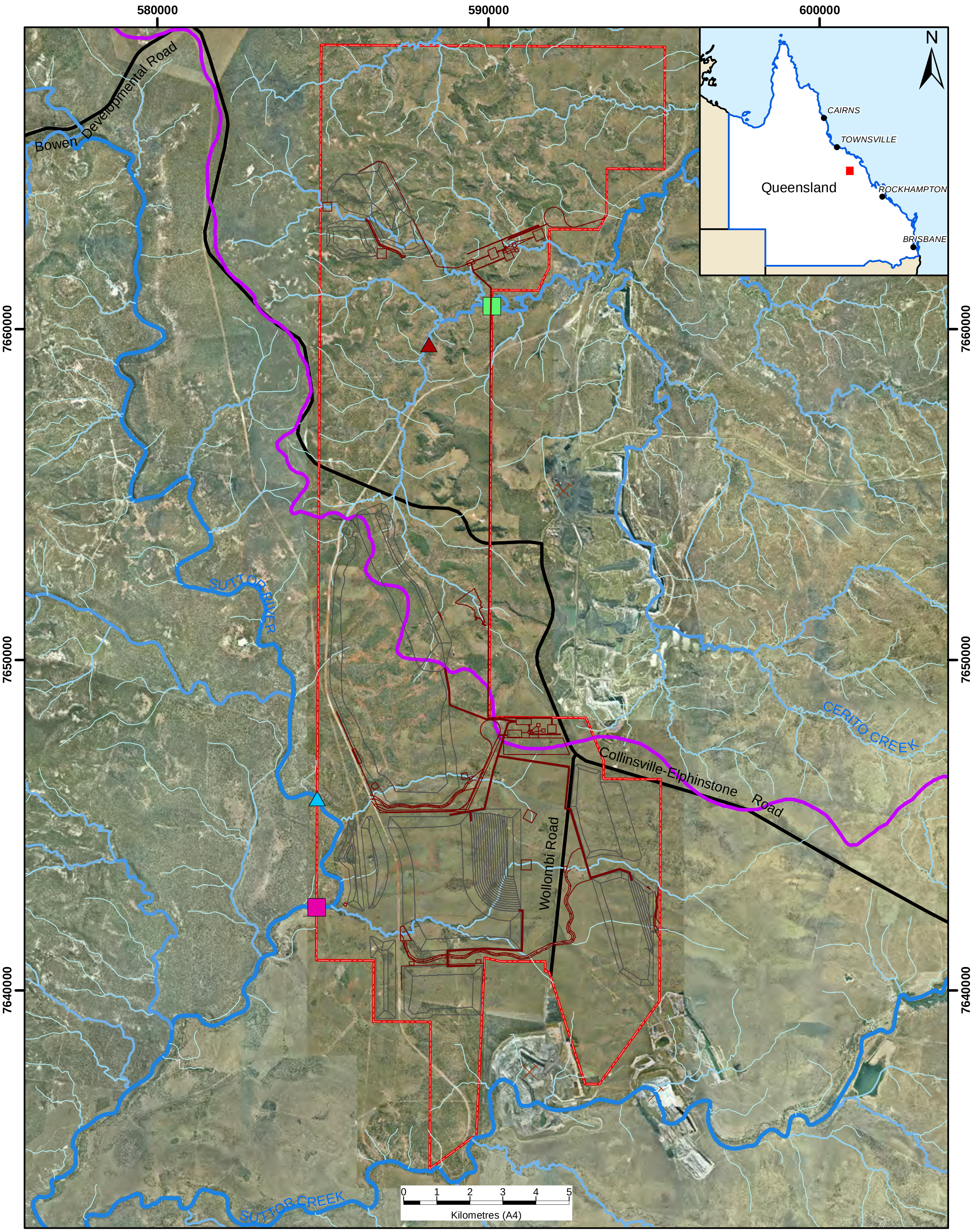
Discharge of mine affected water to the environment will be undertaken on the basis of:

- End-of-pipe water quality: This controls the water quality that enters the environment. A range of water quality indicators will be used to ensure the water quality is suitable for release. The salinity limits (measured as electrical conductivity) vary based on the flow in the receiving waterway.
- Flow in the receiving environment, measured upstream of the mine site releases: Discharges will only be permitted during or immediately following flow in the receiving environment.
- Receiving waterway (downstream) water quality: This controls the water quality in the receiving environment at a downstream location, below a mixing zone. This provides an opportunity to utilise dilution in the receiving waterway, while ensuring that the water quality in the receiving waterway is maintained within a range experienced in the natural environment.

Two receiving environment flow monitoring and water quality compliance locations are shown in **Figure 15-8** and are:

- **MP1** – Suttor River flow gauging station upstream of mine releases at the edge of project area (Easting 584817; Northing 7645806).
- **CP1** – Suttor River downstream of mine releases at edge of project area (Easting 584806; Northing 7642521).
- **MP2** - Kangaroo Creek flow gauging station upstream of North Pit releases (Easting 588199; Northing 7659529).
- **CP2** - Kangaroo Creek downstream of North Pit releases at edge of project area (Easting 590101; Northing 7660695).

Controlled releases from the mine site would occur in accordance with the release conditions described in **Chapter 8**.



Legend

- Project Area
- Mine Infrastructure
- Waste Rock Dumps and Pits
- Drainage Basin Sub-Area
- Existing Mine Site
- Formed Roads

Compliance Points

- CP1
- CP2

Water Flow Monitoring Points

- MP1
- MP2

Drainage (Stream Order)

1 2 3 4 5

Proposed Compliance Points and Water Quality Monitoring Sites

QCOAL GROUP

Figure 15-8

Byerwen Coal Project

Date: *4/02/2013*

Author: samuel.ferguson

Map Scale: 1:150,000

Revision: R1

Coordinate System: GDA 1994 MGA Zone 55

environmental and licensing professionals pty ltd

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15.7.6 Mine Water Discharges

The release conditions specify the maximum discharge rate and end-of-pipe EC that can occur, however the actual release rate and EC will depend on the flow and dilution available in the receiving environment. The water balance model indicates that these maximum conditions are often not met because of downstream constraints. **Table 15-10** summarises the modelled mine water discharges into the Suttor River.

Table 15-10 Suttor River Mine Water Discharge Analysis

	Recession/Low flow	Medium flow	High flow
% of time when releases occurring	7%	18%	75%
% of release water volume	1%	5%	94%
Mean rate of water discharged (ML/d)	7	11	54
Mean EC released (µS/cm)	950	950	930
Maximum EC released (µS/cm)	1,720	2,440	3,680

The table indicates that releases most often occur during high flow conditions (75% of the time when releases occur it will be at times of high flow) and that most of the mine water gets released during high flow conditions (94% of the total volume of water released is at high flow conditions). This is because higher discharge rates and dilution ratios are possible during high flow events.

The table also indicates that recession flow is not a major component of the mine water release strategy. Modelling suggests that only around 1% of the volume of water released occurs during recession flow.

Table 15-11 summarises the modelled mine water discharges into Kangaroo Creek.

Table 15-11 Kangaroo Creek Mine Water Discharge Analysis

	Recession/Low flow	Medium flow	High flow
% of time releases occurring	14%	52%	34%
% of release water volume	2%	30%	68%
Mean rate of water discharged (ML/d)	7	23	79
Mean EC released (µS/cm)	960	950	820
Maximum EC released (µS/cm)	1,300	2,100	2,200

The table suggests that releases to Kangaroo Creek may occur more frequently in medium flow conditions than in Suttor River. However, the majority (approximately 70%) of water discharged from the mine (in terms of volume) would be associated with high flows in Kangaroo Creek.

15.7.6.1 Suttor River Salinity

The mine water balance model (refer **Chapter 8**) comprises modelling, in the mine water management system, of the volume of water and the salinity of water. The salinity of water is the primary constraint to the release of water from the mine water management system.

By virtue of the release conditions, there is expected to be no change to the 80th percentile EC in the Suttor River since no releases are permitted from the mine when the EC in the Suttor River upstream of the mine is 2,040 µS/cm or above.

The water balance model suggests that there is a very slight increase EC below the 80th percentile, reflecting the effect of the releases. However these are of a very low order (10s of µS/cm) and would not have measurable impact on the river water quality.

The effect in terms of salt load (flux) in the Suttor River is shown in **Table 15-12**.

Table 15-12 Suttor River Salt Balance (Cumulative Volumes Over 46 Year Mine Life)

	Source	Without the Project (Tonnes)	With the Project (Tonnes)
Inflows	Suttor salt flux upstream	1,138,000	1,138,000
	Runoff salt captured by the project	101,000	113,000
	Ground water salt	0	9
Storage	Dams	0	1
Outflows	Suttor salt flux at compliance point	1,239,000	1,246,000
	Dust Suppression	0	13,000
Net Gain/Loss		0	0

15.7.6.2 Kangaroo Creek Salinity

The water balance model suggests similar findings for Kangaroo Creek as described above for Suttor River. The effect in terms of salt load (flux) is shown in **Table 15-13**.

Table 15-13 Kangaroo Creek Salt Balance (Cumulative Volumes Over 46 Year Mine Life)

	Source	Without the Project (Tonnes)	With the Project (Tonnes)
Inflows	Kangaroo salt flux upstream	186,000	186,000
	Runoff salt captured by the project	56,000	62,000
	Groundwater salt	0	10,000

	Source	Without the Project (Tonnes)	With the Project (Tonnes)
Storage	Dams	0	1,000
Outflows	Dust suppression	0	13,000
	Kangaroo salt flux at compliance point	242,000	244,000
Net Gain/Loss		0	0

15.8 Monitoring Requirements

A water quality monitoring program will be implemented within the project area for the life of the project. The monitoring requirements for surface water are included in the EMP (**Appendix 9**). Monitoring is proposed for water storages, release points and the receiving environment. **Table 15-14** provides the water quality characteristics which will be assessed as part of the program.

A Receiving Environment Monitoring Program (REMP) will be developed to assess the local receiving waters for the specified discharge locations. The purpose of the REMP is to assess the overall condition of the local receiving waters. **Table 15-14** provides an indication of the likely water quality characteristics which will be assessed as part of the program, and would be confirmed during development of the REMP.

Table 15-14 Monitoring Program

Location	Number of Locations	Quality Characteristic	Monitoring Frequency
Water storages	Varies throughout mine life	pH	Quarterly
		Electrical conductivity	
		Sulfate	
		Aluminium (total)	
		Copper (total)	
		Lead (total)	
		Nickel (total)	
		Uranium (total)	
		Zinc (total)	
Release points	Varies throughout mine life	Aluminium (total and filtered)	Commencement of release and thereafter weekly during release
		Cadmium (total and filtered)	
		Chromium (total and filtered)	
		Copper (total and filtered)	
		Iron (total and filtered)	
		Lead (total and filtered)	
		Nickel (total and filtered)	
		Zinc (total and filtered)	

Location	Number of Locations	Quality Characteristic	Monitoring Frequency
		Boron (total and filtered)	
		Manganese (total and filtered)	
		Molybdenum (total and filtered)	
		Selenium (total and filtered)	
		Silver (total and filtered)	
		Uranium (total and filtered)	
		Vanadium (total and filtered)	
		Ammonia	
		Nitrate	
		Petroleum hydrocarbons (C6–C9)	
		Petroleum hydrocarbons (C10–C36)	
		Sodium	
		Electrical conductivity	
		pH	
		Turbidity	
		Suspended solids	
		Sulfate	
Receiving environment	4 (2 compliance points, 2 upstream monitoring points) Palustrine wetland	pH	Daily (during the release of mine water); Monthly (of natural flow)
		Electrical conductivity	
		Turbidity	
		Suspended solids	
		Sulfate	
		Sodium	

Biological indicators such as macroinvertebrate surveys will also be periodically undertaken. Refer to **Appendix 19** for further details.

15.8.1 Unplanned Discharges

The design of the water management strategy reduces the risk of unplanned discharges to the environment (refer to **Chapter 8**). However, unforseen events may create situations which are beyond design capacity of the management system, or constitute equipment failure or operator error.

The time at which such events may occur cannot be predicted, however it is reasonable to assume they would be associated with high rainfall periods when there is also likely to be high flows in the receiving environment.

In terms of water quality impacts, this means that the unplanned release is likely to be a small component of the existing flow. The main water quality concern associated with the project is salinity, and any salinity associated with unplanned releases would quickly be diluted.

Contingency measures for water surplus and water deficit scenarios are also described in **Chapter 8**.

15.9 Conclusion

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. Within the project area, Kangaroo Creek consists of a largely sandy, ephemeral watercourse with sections of cobbles in the upper reaches.

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. Within the project area, the Suttor River consists of a large sandy, meandering watercourse. The river is ephemeral, with flow likely less than 40% of the time. Recessional baseflows in the river link a series of pools at times of low runoff.

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 water quality objectives were derived specifically for the study area.

No EVs are attributed by the EPP (Water) to the watercourses within the study area; therefore site-specific EVs 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 EVs provided within the Burdekin WQIP Catchment Atlas (Dight, 2009).

The ecosystem condition that is most appropriate for affected waterways under ANZECC guidelines is a SMD system. The appropriate water types are ‘upland streams’ and ‘lowland streams’, as defined by the 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.

It will be necessary for the project to release water to the environment to balance the mine water inventory. This will be achieved through a controlled release strategy that allows discharge into waterways (when specific flow and water quality criteria have been satisfied). Two receiving environment compliance locations are proposed with associated upstream monitoring points, one on Kangaroo Creek and a second on the Suttor River.

The proposed WQOs are used as the basis for developing mine water release criteria. For the majority of parameters, the WQO values in the QWQG 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 QWQG is considered appropriate to be used as the basis for future management of water quality for the project.

Salinity of mine affected water is the key constraint to water quality intended for release. Other water quality parameters will be measured during operations against the WQO’s. In addition to EC, these ‘end of pipe’ or ‘hard’ limits include release limits (maximum values that cannot be exceeded by the project) for pH, turbidity and sulphate.

Monitoring trigger investigation levels would also apply (using 2 compliance monitoring points – one for each catchment). Monitoring trigger investigation levels 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. Monitoring trigger investigation levels apply to a suite of parameters including metals.

A monitoring program will be developed to monitor water quality in project water management infrastructure (i.e. dams and at release points) and in the receiving environment.

Adherence to the mine water release criteria based on the draft WQOs shown in **Table 15-9** together with fulfilment of the requirements of the REMP (**Table 15-14**) is expected to protect the EV's and objectives described within **Table 15-1** for water quality within the sub-catchment areas, resulting in minor impacts to surface water quality.