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9.1 INTRODUCTION

This Chapter provides an assessment of surface waters for the mine component of the project. The assessment identifies the existing environmental values of surface waters within and surrounding the mine site, assesses potential impacts resulting from the mine component of the project and identifies management measures to mitigate the described impacts.

9.2 LEGISLATIVE FRAMEWORK

9.2.1 WATER ACT 2000

The *Water Act 2000* (Water Act) is the primary statutory document that establishes a system for the planning, allocating and use of non-tidal water in Queensland. The Act is administered by the Department of Environment and Resource Management (DERM) and specifies requirements for works requiring disturbance to the bed and banks of watercourses (e.g. stream diversions).

The Water Act outlines the process for preparing Water Resource Plans (WRP) and Resource Operation Plans (ROP) which are specific for Catchments within Queensland. Under this process, the WRP identifies a balance between waterway health and community needs. WRPs and ROPs determine conditions for granting water allocation licences, permits and other authorities, as well as rules for water trading and sharing. The Water Act makes the provision for the preparation of land and water management plans in specific areas. There are no such plans in place in the vicinity of the Project.

The project is located within the Belyandor sub-catchment area covered by the Burdekin Basin Water Resource Plan 2007 (refer WRP Schedules 1 and 2). The Project site is outside (excluded) of declared Water Management Areas in Part 2 Section 6 of the Burdekin Basin WRP.

9.2.2 ENVIRONMENTAL PROTECTION ACT 1994

The EP Act provides a range of tools including Environmental Protection Policies (EPPs). The purpose of the Environmental Protection (Water) Policy 2009 (EPP (Water)) is to achieve one of the objectives of the EP Act, this being the protection of Queensland water while allowing for ecologically sustainable development. The EPP (Water) outlines the process for setting environmental values (EVs) and Water Quality Objectives (WQO's) for waters within Queensland. No specific EVs or WQOs have been established for the study area.

9.2.3 QUEENSLAND WATER QUALITY GUIDELINES 2009

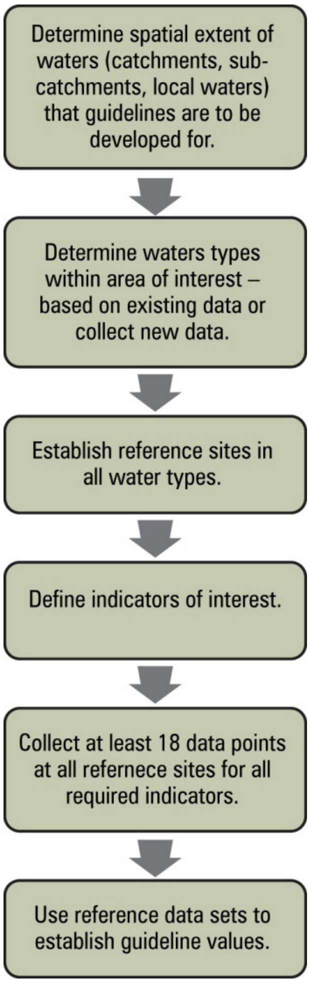
In Queensland waters, DERM's *Queensland Water Quality Guidelines* (2009a) (QWQG) are given precedence over other recognised guidelines such as *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZECC AND ARMCANZ 2000)as they are more localised giving them a higher weighting under the EPP *(Water)*. The QWQG have been created to provide monitoring criteria tailored to Queensland regions and water types as well as a process/framework for deriving local or site-specific guidelines for waters in Queensland.

There are three levels of aquatic ecosystems listed in the guidelines, these being High Ecological / Conservation Values (HEV), slightly to moderately disturbed systems and highly disturbed systems. The three levels are afforded varying degrees of protection with high ecological value systems allowed "no change from ambient conditions, unless it can be demonstrated that such change will not compromise the maintenance of biological diversity in the system" while slightly to moderately and highly disturbed systems are allowed "some change depending on the level of disturbance present in the system".

The mine is located predominantly on land cleared for grazing or other purposes therefore it is considered to be a slightly to moderately disturbed ecosystem as described in the QWQG.

Section 4 of the QWQG provides a procedure for deriving water quality guidelines for aquatic ecosystem protection. This procedure has been used as a guide to developing compliance criteria for the upper Belyando catchment (Figure 1).

Figure 1. QWQG process for determining Water Quality Guidelines



9.3 ASSESSMENT METHODS

9.3.1 DESKTOP REVIEW

Commonwealth, Queensland and regional databases and guidelines were reviewed to identify surface waters within and adjacent to mine. Specific information sources include:

- BOM for climate and flooding data for the study area;
- review of relevant Commonwealth, Queensland, and Local Guidelines and Standards including the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZECC AND ARMCANZ 2000) and *Queensland Water Quality Guidelines* (DERM 2009a);
- DERM monitoring programs for historical water quality data; and
- published and grey literature.

The objective of the desktop review was to obtain an overview of surface water quality in the project study area and identify data gaps so that field surveys could be targeted to obtain the relevant information.

9.3.2 FIELD SURVEYS

Field surveys involving the collection of biological and physical data from streams within the study area were undertaken in dry (October 2009) and wet (March / April 2010) seasons. Sampling comprised the testing of physical water quality parameters and the collection of samples for laboratory analysis. Frequency and timing of surface water sampling was dependent upon seasonal variation of rainfall and access to site locations. Observations of stream channel morphology and riparian vegetation were made using the *Australian River Assessment Scheme 1997* (AusRivas) methodology.

9.3.2.1 Sample Locations

Field studies were undertaken over two temporal events (dry and wet) to account for seasonal variation in water quality. A total of nine sites were sampled within or adjacent to the proposed Mining Lease Boundary (MLB) over the two temporal events. Site locations were selected from the results of the desktop assessment and were based on the location of the infrastructure, likelihood of flowing water being present over both seasons, access and catchment size. The locations of the sites are shown on Figure 2. The Cooper Creek Catchment intersects the MLB and footprint of underground mining area in the south west corner of the site. This Catchment is not hydraulically linked to the area where works will take place for the Galilee Coal Project and therefore this area was not been included in the sampling program.

During dry field sampling, only one of the sites in the Belyando Catchment contained sufficient water to carry out sampling. During wet season all nine sites contained flowing water. Wet season sampling was carried out in the week immediately following Cyclone Ului crossing the Whitsunday coastline, resulting in a number of the streams overflowing and thus restricting access to the banks for sampling. Where this occurred, sampling was carried out as near to the dry season sample location as possible. Generally samples were taken within 200 m of the dry season site.

9.3.3 WATER QUALITY DATA COMPARISON

Results from baseline sampling were compared to the most relevant surface water quality guidelines available to provide an indication of existing water quality in the assessed Catchments. The QWQG provides guidelines for the Queensland Central Coast (Burnett River Basin to the Black River Basin), which coincides with the Brigalow Belt and New England Tableland Bioregions (DERM 2009a). Guideline values for the Central Coast Queensland Region are provided in Table 1. The values listed are for *slightly to moderately disturbed* upland streams.

The QWQG does not include values for metals and metalloids. Therefore ANZECC AND ARMCANZ guideline values for 95% species protection in freshwater have been used for comparison (Table 2).

Table 1. QWQG 2009a Central Coast Regional Guidelines (slightly to moderately disturbed waters)

	PHYSIO-CHEMICAL INDICATORS AND GUIDELINE VALUES (SLIGHTLY TO MODERATELY DISTURBED SYSTEMS)										
	AMMONIA AS N	TOTAL N (µG/L)	TOTAL P (µG/L)	CHL-A (µG/L)	DO% LOW – UP		TURBIDITY NTU)	SS (MG/L)	PH LOW – UP		COND MS/CM
Upland streams	10	250	30	NA	90	110	25	–	6.5	7.5	0.18

Table 2. ANZECC AND ARMCANZ Guidelines for 95% Species Protection in Freshwater (Metals and Metalloids)

METAL/METALLOID	TRIGGER VALUES (µG/L) FOR 95% PROTECTION
Arsenic	24
Cadmium	370
Chromium	-
Copper	1.4
Nickel	11
Lead	3.4
Zinc	8
Iron	-

Note: Trigger Values does not exist

9.3.4 FLOOD ASSESSMENT

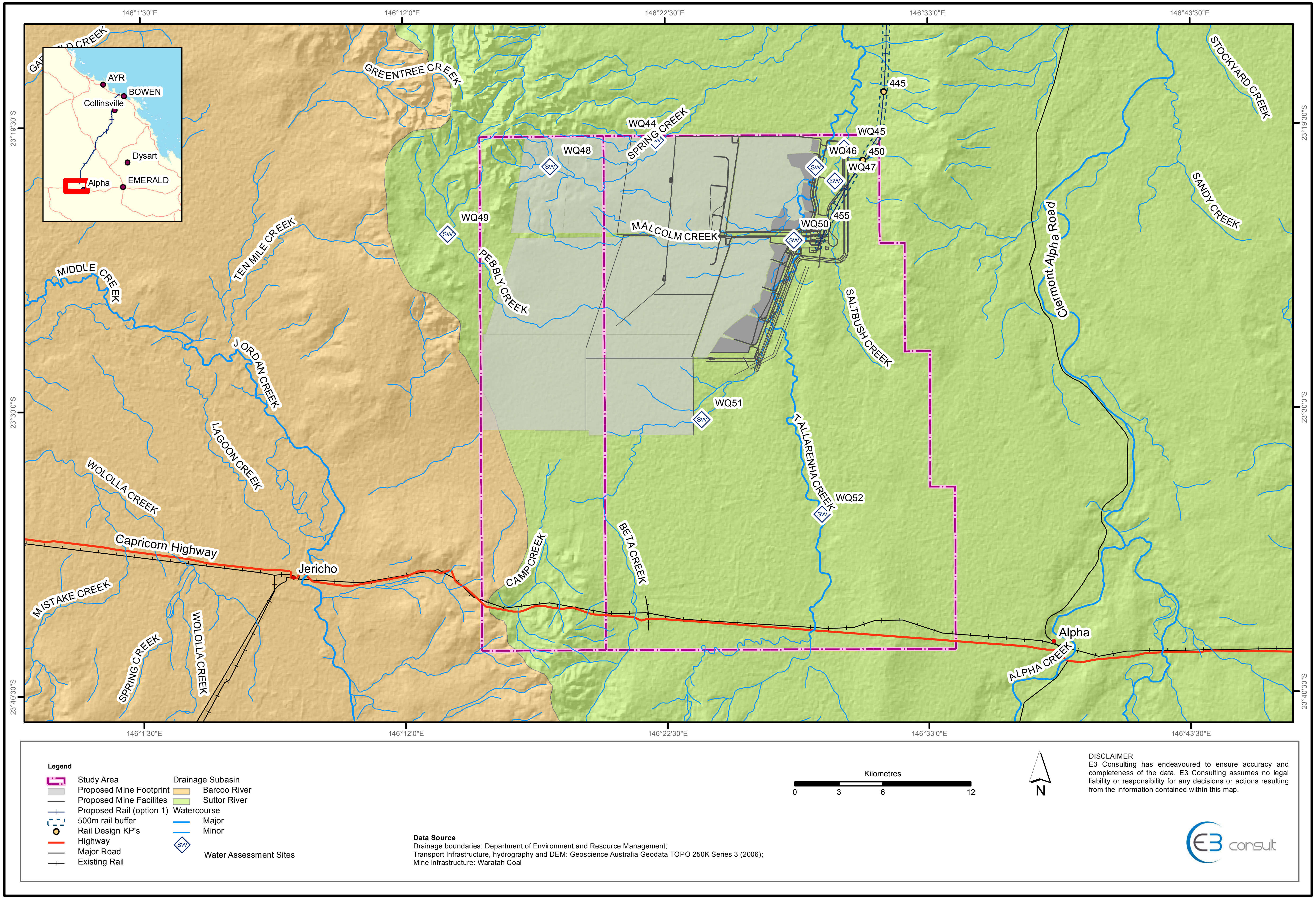
An analysis of regional flooding has been undertaken for each of the major and a select number of minor waterways within the tenement areas to assess flooding behavior.

The analysis has been undertaken using the latest in rainfall runoff (hydrology) and hydraulic modeling packages, namely the XP-RAFTS hydrologic and TUFLOW hydraulic software packages to accurately determine the existing flood behavior within the site.

An XP-RAFTS hydrologic model was created to predict the catchment response for use in the hydraulic models developed as part of this study. The hydrologic model was simulated for the 10, 50 and 100 year Average Recurrence Interval (ARI) design rainfall events using a range of storm durations to estimate the relevant design event peak flows. Model parameters were derived from aerial photography of the site as well as review of historical rainfall and gauging station records, and Australian Rainfall and Runoff recommendations.

TUFLOW hydraulic model developed for this study was based on the DERM supplied Burdekin Basin 25 m Digital Elevation Model (DEM) collected as part of this study. Various model parameters have been optimised by use of aerial photography. Although the Capricorn Highway passes through the most upstream extent of the site, in order to be conservative and in the absence of detailed structure details, the highway has not been represented in the hydraulic model. As such, no drainage structures have been included in this modelling analysis. The hydraulic model constructed for this assessment was simulated for the 10, 50 and 100 year ARI design rainfall events.

Figure 2. Water Quality Sampling Sites



9.3.5 MINE WATER MANAGEMENT SYSTEMS

Waratah Coal will develop a Mine Water Management Plan (MWMP) to assist in identifying all water management issues associated with developing, operating and decommissioning the mine. At a minimum this assessment will include the following:

- development of surface water management system concepts for the various phases through the Project life;
- methods for diverting runoff from undisturbed catchments (clean water) around the project area;
- segregation of waters within the project site based on expected quality;
- reuse of contaminated water around site, with contaminated water preferentially reused in the mine operations for coal processing; and
- preparation of a water balance model of the project site to estimate runoff volumes and simulate the balance of runoff (and other mine water generation) with mine water consumption to identify potential overflows and identify potential water deficits / surpluses for the Year 1, 5, 10, 20 and 30 landforms.

This will be put in place prior to the commencement of construction and developed in using the following reference documents:

- Technical Guidelines for the Environmental Management of Exploration and Mining in Queensland (Department of Mines and Energy, 1995);
- Manual for Assessing Hazard Categories and Hydraulic Performance of Dams (DERM 2009b).
- Code of Environmental Compliance for Environmental Authorities for High Hazard Dams Containing Hazardous Waste (DERM, 2011);
- Conditions for Coal Mines in the Fitzroy Basin Approach to Discharge Licensing (being developed by DERM – see http://www.fitzroyriver.qld.gov.au/projects/index.html.); and
- Model Water Conditions for Coal Mines in the Fitzroy Basin (being developed by DERM – see http://www.fitzroyriver.qld.gov.au/projects/index.html).

The MWMP will be developed prior to construction once mine layout and design is finalised.

9.4 DESCRIPTION OF EXISTING ENVIRONMENT

The mine footprint is located entirely within the Upper areas Belyando Catchment, which is the largest sub-catchment of the Burdekin River Basin, covering an area of approximately 73,000 km^2. Some of the major tributaries of the Belyando River include Mistake, Native Companion and Sandy Creeks.

9.4.1 TOPOGRAPHY AND LAND USES

The Belyando Catchment is predominately low relief floodplain with wide braided channels and alluvial plains (Rogers *et al.*, 1999). The section of the Catchment covering the mine is comprised of gently undulating plains with strongly undulating to hilly land in the north-east corner of the Exploration Permit Coal (EPC). Surface geology at the mine is dominated by unconsolidated Cainozoic sediments including sands, silts and clay, with thickness of up to 90 m in the eastern and central sections of the EPC. Soils at the mine are structure less and are mostly well drained and permeable with low fertility.

The Belyando Catchment is predominantly agricultural land with cattle grazing on natural vegetation. Cropping and/or horticulture are not undertaken within the EPC. The vegetation within the mine open cut footprint is generally characterised as being in a degraded condition having been cleared and blade ploughed for grazing land.

9.4.2 RIPARIAN CONDITION

Riparian areas in the Catchment generally consisted of layer of mature Eucalypts, including ironbark species, one or two trees thick directly on the banks of the streams. These are surrounded by a layer of saplings and shrubs before the landscape opens up into grazing paddocks. Soils were mostly clays and fine sediment.

Riparian vegetation density was varied across the sites. Site WQ45 had significant larger tree species (35-65% >10 m tall) while the majority had <10% large trees. The majority of sites had highly disturbed vegetation and accordingly, trees less that 10m and grass were the dominant vegetation.

The streams are generally small (<5 m wide). The riparian areas had obvious signs of anthropogenic impacts (clearing for agriculture). WQ45 had broken its banks when wet weather sampling was carried out while others showed evidence of recent flooding such as scour and scattered debris.

9.4.3 MORPHOLOGY

The streams in the upper reaches of the Belyando Catchment were predominantly remnant channels that were either flat or shallow banked streams. The streams were usually <5 m wide although most streams had an observed flood plain that extended up to 50 m either side of the centre of the stream. Most streams sampled had pooled water although two streams (WQ44 and WQ48) had flowing water (runs) that equated to between 10-35 % of the reach. The majority of the streams had limited aquatic plant growth except for sites WQ46 and WQ47 that had significant submerged aquatic plants. Site WQ45 was located within a permanent lagoon that is restricted by a small ford and had the least disturbed vegetation.

Sand was the dominant particle observed at all sites although in some locations, this overlaid a silty clay substrate. Only WQ44 had a bedrock base (65-90 % of its banks). Erosion varied across the streams located on the mine. The streams ranged from having severe erosion to server deposition. The majority of streams were partly or moderately restricted to base flow. All but site WQ47 had some form of barrier to water flow such as a sand bank.

Photographs of the stream that are likely to be impacts as a result of the construction of the mine are provided the Surface Water technical report, Volume 5, Appendix 15. This includes photographs of Tallarenha Creek and Lagoon Creek which are proposed to be diverted (re-aligned) around the eastern side of the mine.

9.4.4 FLOODING HISTORY

The Belyando catchment has variable rainfall and relatively flat topography which can result in localised flooding occurring during rainfall events of 200 mm over a 48 hour period. Flooding generally occurs during summer months as a result of heavy rainfalls caused by tropical lows and rain depressions generated from cyclones crossing the Queensland coast.

The BOM provides a brief summary of flooding within the Burdekin River Basins whilst a detailed summary of historical flooding from 1950 to present (2011) within the Burdekin River Basin has been included in Table 3. A general flood summary for the Burdekin River Basin from the Bureau of Meteorology states that:

'Burdekin River: Major floods, causing inundation of properties and closure of main roads, can occur along the major rivers both upstream and downstream of the Burdekin Falls Dam. Downstream of the Dam, major flooding in the Ayr and Home Hill areas results from either flood waters travelling down from the upper Burdekin and Belyando basin or from intense rain in areas below the Dam.' (BOM, 2011)

Table 3. Flooding History in the Belyando River Basin

EVENT DATE	DESCRIPTION
April 1950	Heavy rains from 1st to 8th over the central interior resulted in much low level flooding and traffic disabilities. Strong stream rises also occurred in Cooper Creek, Barcoo, Thomson, Bulloo, Paroo, Warrego, Belyando, Flinders, Mackenzie, Dawson and Isaacs rivers. The general rains of 10th and 11th over the southern interior caused freshes in the Condamine and Balonne rivers. Many main traffic bridges were under water for several days and the discharge from the Belyando River and adjacent smaller streams kept the Burdekin River just under bridge level for most of the month. Fairly extensive traffic disabilities were also experienced on the north tropical coast during the first half of the month due to the heavy rains that fell during this period.
July 1950	Following the heavy rains of the previous 5 to 6 months, the persistent wet weather and record rainfalls during the month caused State wide flooding reports except in the Carpentaria and far western border areas. In all other parts of the State traffic disabilities and low level flooding was extensive and considerable flood water damage and stock and crop losses were reported, particularly in the southern interior. Flooding was most severe in the Maranoa, Macintyre, Condamine and Balonne rivers with record or near record levels. The Maranoa River at Mitchell peaked on 27th, (highest on record). The Macintyre River at Goondiwindi peaked on 30th, the highest since March 1890. The Balonne River at St George peaked on 31st, (highest on record). Other main streams which reached moderate to high flood levels were the Warrego, Thomson, Barcoo, Belyando, Dawson, Mackenzie, Nogoa and Mary rivers.
November 1950	State wide stream rises were reported in the third week of the month resulting from the heavy widespread rains during this period. These rises were only moderate in the South Coast streams, Condamine and Macintyre river systems and the lower Burdekin River. In all other streams, particularly the Nogoa, Mackenzie, Dawson, Belyando, Warrego, Thomson and Barcoo river systems, record or near record flood levels were reported. By the close of the month all these streams were still carrying heavy flood run-off. Low level flooding dislocation and property damage was extensive and some stock losses were reported, whilst it appears likely that one life was lost in the Nogoa River.
December 1950	Due to the heavy flood rains of November all streams in the central, southern and south-west interior were carrying heavy flood run-off early in December. By the end of the first week all these streams had reached their peak heights and were falling. Heavy rains on the tropical coast in the first week of the month caused further traffic disabilities and considerable damage to sugar cane crops was reported. Flood rains from 19th to 21st, giving several totals of 150 to 225 mm in the north-western parts of the State, caused strong stream rises in the Flinders River and other Gulf streams and further rises in the Thomson and Barcoo rivers and the Cooper Creek system. By the end of the month the Flinders River downstream at Milgarra was still rising and in western Queensland floodwaters were still hampering surface traffic.
January 1956	From 16th to 19th flooding was reported in western Peninsula streams, mainly the Gilbert, Norman and Mitchell rivers. Practically state-wide rains resulted in flooding of most catchments during the last 10 days of the month, when moderate flooding was reported in the Fitzroy, Kolan, Burnett and upper Brisbane rivers, and freshes occurred in other south coast streams. Slight flooding was also reported in the Flinders, Thomson and Belyando rivers.
March 1960	In the Burdekin River catchment a fresh in the Belyando River from 1st to 3rd and moderate flooding in the upper Burdekin on 11th and 12th resulted in some rises in the lower Burdekin from 11th to 15th. Peaks in the upper Burdekin were Green Valley and Clarke River, both on 12th.

EVENT DATE	DESCRIPTION
February 1962	This condition of swollen streams and widespread traffic disruption, which extended along the north coast as far south as Mackay by 20th, continued throughout the month. The Fitzroy, Belyando and Burdekin systems were all affected, whilst flooding in the Herbert River from 27th submerged traffic bridges at Long Pocket and North Gairloch. Flooding; however, was only minor.
March 1963	The heavy rain period near the end of the month produced moderate rises in other rivers over a wide area of the State. In the Fitzroy River catchment large volumes of water moved down all tributaries with the highest levels being recorded in the western parts of the catchment. Other systems affected were the Flinders, Belyando, Condamine, Balonne, Moonie, Maranoa and Paroo rivers. Huge volumes of flood run-off, with rivers up to 35 kilometres wide in places, were moving south towards New South Wales and South Australia at the end of the month, particularly in the Cooper Creek and Bulloo systems.
March 1965	Flooding in the Cloncurry, Corella and Gilbert rivers followed general rainfalls of 50 to 100 mm in Carpentaria districts between 8th and 12th. The area of rain also extended south into the central lowlands, where freshes were produced in the Thomson, Barcoo and Belyando rivers, and west into the Northern Territory, where a moderate flood occurred in the Georgina River. Associated heavier falls on the northern catchment of the Burdekin River produced a slight flood which peaked at Clare on 14th.
January 1966	Heavy rainfall on the central coast on the 24th and 25th produced rises in the northern tributaries of the Fitzroy River system and the southern tributaries of the Burdekin River system. Near the end of the month flooding occurred in the Mackenzie, Isaacs, Belyando, Bogie and Burdekin rivers.
January 1970	As a result of Cyclone “Ada”, major flooding was experienced in the Pioneer River, particularly at Mackay on 19th, and in the Don River at Bowen on 19th and 20th. Severe local flooding occurred in coastal streams affecting towns between Sarina and Bowen. Major flooding occurred in the Bowen and Broken rivers in the Burdekin basin, but only moderate flooding occurred in the lower Burdekin River. Major flooding was experienced also in the upper catchments of the Isaacs and Connors rivers and in Funnel Creek, all far northern tributaries in the Fitzroy basin. However only moderate flooding occurred in the lower Mackenzie River and only river rises below flood level resulted in the Fitzroy River.
February 1970	A fresh in the Burdekin River was complemented by rains of up to 110 mm in the lower catchments, causing minor flooding downstream of Dalbeg on 5th and early 6th. Scartwater on the Belyando River recorded moderate flood heights on 4th, 5th and 9th. However the effects were localised as stations both upstream and downstream were just below flood heights.
December 1970	Flooding occurred in most rivers in south-east Queensland, in the area south from the Comet and Belyando rivers and east from the Warrego River. In the second week, flooding also occurred in Brisbane City metropolitan creeks and streams. The rivers, together with the degree of flooding, were Belyando [minor], Comet [moderate], Dawson [major], Mary [minor], Stanley [moderate], upper Brisbane, Lockyer and Bremer [minor], Pine, Albert and Logan [moderate], Nerang [minor], Condamine and Balonne [major], Maranoa [moderate], Macintyre and Weir [major], Warrego and Moonie [moderate], and Barcoo [major].
February 1973	In the north of the State, minor to moderate flooding occurred in the Fitzroy system in the Connors River and Funnel Creek, extending into the lower Isaacs River, with traffic disabilities for up to two days. Minor flooding also occurred in the Belyando, lower Burdekin and Flinders rivers.
January 1980	The overland track of the tropical low, which became tropical Cyclone”Paul”, caused one of the highest floods this century in the Don River catchment, resulting in the river changing its course in the lower reach and washing away two homes. The cost due to the extensive damage to the market garden industry is estimated to be several million dollars. Major flooding also occurred in the Pioneer and Proserpine river catchments and the lower reach of the Haughton River. Other streams also to reach flood levels from heavy rains during the period when Cyclone “Paul” was on the synoptic charts were the Thomson River, Connors River and tributaries and the Burdekin River. Flood levels in these streams were minor to moderate, and apart from traffic disabilities, no damage reports were received.

EVENT DATE	DESCRIPTION
December 1987	On 29th, in the lower reaches of the Paroo River, minor to moderate flooding and minor flooding in the lower reaches of the Bulloo River. Both continued till the end of the month. On 30th, moderate flooding and traffic disabilities started in the Belyando and Cape rivers in the Burdekin Dam catchment and continued till 31st. Moderate flooding in the Georgina River around the Glenormiston area on 31st.
January 1988	Continuing from the previous month, minor flooding in the Paroo, Belyando and Cape rivers till 4th. Moderate flooding in the Georgina River till 7th and minor flooding continued in Eyre Creek till 14th.
April 1989	Major flooding occurred overnight and produced a peak of 7.8 m at Mackay early on Wednesday 5th. Major flooding in the Proserpine River and moderate flooding in the Don River occurred during the 4th. Moderate flooding occurred in the Burdekin River below the dam from heavy tributary runoff causing a moderate flood peak of 10 m at Inkerman Bridge.
April 1990	Major flooding also occurred in the Thomson River and Cooper Creek, the Bulloo and Paroo rivers, Nebine, Wallam and Mungallala creeks, Balonne, Macintyre Nogoa, Dawson and Belyando rivers, with heights approaching record levels in a number of these streams.
December 1990	General southwest movement of Cyclone "Joy" and eventual landfall in the Ayr region, led to severe local flooding along the Central Coast. Major flooding occurred on the 27th in the Pioneer, Don and Haughton rivers, with minor flooding in the Lower Burdekin River
January 1991	Continued heavy rainfalls caused by ex-Cyclone "Joy" along coastal areas caused minor to moderate flooding to develop in all coastal streams between Cairns and Gladstone during January. Flooding in the Tully, Herbert, Haughton, Lower Burdekin, Don, and Pioneer rivers caused widespread traffic hazards, flooding of low lying properties and isolation of towns for several days. Serious flooding occurred in the small township of Giru on the Haughton River as floodwaters broke their banks and flooded many houses and streets of the town in early January.
February 1997	Don River: During 24th to 25th, minor flooding occurred in the Don River. Burdekin River: The heavy rainfall from Cyclone "Ita" resulted in some heavy rainfalls in the headwaters of the Bowen River which resulted in some minor to moderate flooding in the Burdekin River below Burdekin Falls Dam.
February 2000	Don River: Moderate flooding occurred on three separate occasions in the Don River during February. In early February, moderate flooding occurred at Bowen with two separate flood peaks on the 7th and 8th. Later in the month, a flood of similar magnitude to the larger of the two earlier events occurred on 24th February. Burdekin River: The initial flood warning was issued for the Burdekin River on 22nd February and was not finalised until the end of the month. During this period, minor flooding occurred in the Cape River, lower parts on the Belyando with some significant runoff from the upper Burdekin River. Coupled with heavy local rainfall, this resulted in minor flooding in the lower reaches of the Burdekin River.
November 2001	The first significant river rises for this wet season commenced in the latter half of November. Localised rises were reported in various rivers including the lower Belyando, Dawson, Balonne, Thomson, Alice and Paroo Rivers.

EVENT DATE	DESCRIPTION
February 2002	Don River: Rainfall totals between 100 and 175 mm were recorded in the Don River on Thursday 14th February and resulted in a moderate flood in the lower reaches that afternoon. Burdekin River and tributaries: Very heavy rainfalls were recorded in the upper Burdekin and Cape Rivers during the period 13th to 18th February with the highest total of just over 800 mm at Paluma with widespread falls between 300 and 400 mm. Major flooding resulted in the upper Burdekin and Cape River with the flooding in the Cape system being amongst the highest ever recorded. Minor flooding occurred along the lower Burdekin River from Monday 18th and continued to Thursday 21st February.
January 2005	Don River: Heavy rainfall in the Don River catchment of up to 100 mm during the day of 23 January resulted in sharp river rises and minor to moderate flooding in the upper reaches of the Don River. The river level at Bowen Pump Station peaked overnight on the 23 January with moderate flooding easing during the following day. Burdekin River: Very heavy falls occurred in the catchment of the Burdekin River during 24 January, with over 400 mm recorded at Paluma for the 48 hours to 9am 24 January. Minor to moderate flooding developed in the upper Burdekin River and Cape River and minor flooding in the lower Burdekin River and coastal tributaries during the 25 January. The Burdekin Falls Dam started spilling on 25 January and maintained the minor flood levels downstream at Inkerman Bridge until 28 January before easing
January 2008	Widespread intense rainfall was recorded across many catchments along the Central Queensland coast as the low continued to slowly drift southwards towards the headwaters of the Thomson River, Barcoo River and Cooper Creek during 16th January, producing very intense rainfall over the Belyando River in the Burdekin River basin, Nogoa River and Theresa Creek in the Fitzroy River basin, and very heavy rainfall to other inland and coastal areas. The low continued its southward movement on 17th January producing further intense rainfalls as it tracked over the western parts of the Fitzroy River basin around Emerald, and then along the Warrego River through to Charleville. Very heavy rainfall occurred along the Queensland coast between Townsville and Mackay and inland over the Coalfields and Central Interior between the 10th and 20th January. This rainfall produced widespread flooding across Central Queensland including the Ross River, Haughton River, Don River, and Pioneer River, however the most pronounced and intensive rainfall occurred over the Nogoa River and Theresa Creek within the Fitzroy River Basin and the Belyando River within the Burdekin River Basin. Intense rainfall of 143 mm fell on Giru over 2 hours, whilst the heaviest daily rainfall totals exceeded 300 mm causing flash flooding in the Proserpine and Airlie Beach area. Bogantungun situated to the west of the city of Emerald recorded a 4-day rainfall total of nearly 700 mm.
March 2010	Severe TC Ului crossed the Queensland east coast near Proserpine early on the 21st of March, and then continued to move in west south-west direction across the south-east tropics in a weakening mode. The system produced widespread heavy rainfall and showers on its southern side over the Don, Burdekin, Pioneer, Haughton and Fitzroy River Catchments. Flood warnings were required for the Connors and Isaac Rivers in the Fitzroy River Catchment and also the Don, Haughton and Burdekin Rivers, with only six major flood warnings, namely for the Pioneer River and Funnel Creek and the Connors River in the Fitzroy catchment.
September 2010	Belyando River: Heavy rainfall recorded in the Carnarvon region during September produced rises in Native Companion Creek and major flooding further downstream at Albro station. A Flood Warning for major flooding was issued on the 20th of September and finalised on the 27th. Dawson River: Heavy rainfall in the upper Dawson and Don Rivers and in Juandah Creek produced minor to moderate flooding along the Dawson River. A localised major flood peak of 6.03 m was recorded in the Taroom area.

Source: BOM

9.4.5 EXISTING HYDROLOGY

The EPC1040 and Part of EPC1079 (i.e. the study area) tenement areas have a contributing catchment area of approximately 1,300 km². The tenement area and contributing catchment is located in the BRC area between the towns of Alpha, and Jericho in Queensland, and has a number of waterway systems intersecting the subject areas, all of which lie in the Burdekin River Basin. Waterways intersecting the tenement area include:

- Beta Creek;
- Lagoon Creek;
- Malcolm Creek;
- Pebbly Creek;
- Saltbush Creek; and
- Spring Creek.

All the major and minor waterways influencing the tenement area are described as non-perennial and therefore flow only during intense periods of rainfall. The typical land use in these catchment areas is described as production from relatively natural environments.

As much of the study area is located in the upper reaches of the Burdekin Basin and many sites were shown to be operational for only a limited period, limited historical records were available for analysis. Operational gauging stations available within the study area that were used as a guide to facilitate verification of the hydrologic model results are presented in Table 4. This gauging station was used to provide verification of the adopted 100 year ARI flows within the Belyando River system.

Table 4. Gauging station data summary

GAUGE NO.	GAUGE NAME	YEAR OF PEAK FLOW DATA
120305A	Native Companion Creek at Violet Grove	43

Hydrologic modelling was undertaken for the 10, 50 and 100 year Average Recurrence Interval (ARI) design rainfall events. Each ARI event was simulated with all standard rainfall durations from 60 minutes to 72 hours to determine the critical storm duration. Predicted peak flow rates for each ARI event are shown below in Table 5.

Table 5. Hydrologic Modelling Results – Peak Flow Summary

CROSSING LOCATION	10 YEAR ARI PEAK FLOW (M3/SEC)	50 YEAR ARI PEAK FLOW (M3/SEC)	100 YEAR ARI PEAK FLOW (M3/SEC)
Downstream Boundary	278	560	715

Existing case (pre project) hydraulic modeling predicted that inundation resulting from design rainfall events varied in extent and depth within the tenement area.

Existing case results of the hydraulic modeling indicate that flood depths within the tenement area are typically less than one m within the upper reaches of all the modeled creeks and the mid to lower portion of Lagoon Creek produced depths of up to 2.5 m in the 100 year ARI event and 1.6 m in the 10 year ARI event. For the entire waterway system, the maximum peak depth for the 100, 50 and 10 year ARI events was found to be approximately 2.3 m, 2.06 m and 1.51 m respectively.

Flood velocities within the modeled creeks are typically less than one m/s for all modeled ARI events with velocities within the mid to low portion of Lagoon Creek producing velocities of >2 m/s in the 50 year and 100 year ARI events. Maximum peak velocities in the study area was predicted to be approximately 2.76 m/s, 2.54 m/s and 2.04 m/s during the 100, 50 and 10 year ARI events respectively. These maximum peaks generally occurred in the Lagoon Creek reach (i.e. the mid and lower reaches of the entire waterway system). The average flow width within Lagoon Creek in the 100 year ARI is 400 m whilst the width in the 10 year ARI event was found to be approximately 200 m.

9.4.6 EXISTING WATER QUALITY

9.4.6.1 Upper Belyando Catchment

A review of the DERM historical water quality data indicated that Violet Grove on Native Companion Creek is the closest site to the mine (approximately 20 kms east) where sampling is undertaken regularly. Water quality sampling was carried out at the site between 1991 and 2005. A summary of the water quality data obtained from this site is provided in Table 6.

Table 7 provides a summary of results from the Belyando Catchment. Detailed results for each site in the Catchment are provided in the Surface Water technical report a Volume 5, Appendix 15.

Table 6. DERM Historical Water Quality – Violet Grove summary

PARAMETER	N	MINIMUM	10TH PERCENTILE	MEDIAN	90TH PERCENTILE	MAXIMUM
EC (µS/cm)	34	82	93	147.5	349.8	1589
Turbidity (NTU)	24	9	38.4	360.5	904	1944
pH	30	5.80	6.70	7.35	8.32	8.62
DO (ppm)	24	2.12	4.56	5.75	8.21	9.00
TSS (mg/L)	52	5	19	110	781	1500
TN (µg/L)	9	855	–	–	–	1530
TP (µg/L)	27	27	32	206	409	540

The existing surface water within the Belyando Catchment suggests that the streams are generally of reasonable quality with readings outside of expected ranges explainable by the surrounding land uses and ephemeral nature. The physio-chemical properties are comparable to the QWQG for *slightly to moderately* disturbed upland streams in the central coast region and historical results from historical monitoring carried out in the region.

EC and pH show similar patterns with the median, 20th and 80th percentile either falling within or only marginally exceeding the QWQG upland streams compliance levels. The minimum and maximum for pH and EC exceed the QWQG trigger limits. This is similar to the results recorded at Violet Grove and is likely due to natural fluctuations in the streams.

Dissolved Oxygen (DO) was well below the QWQG trigger limits with only three of the nine samples having a reading of 80% saturation or above. This is likely to be as result of the ephemeral nature of the streams with pools not generating any oxygen during the dry season and high flows during wet season not allowing oxygen uptake. Turbidity also exceeded the QWQG criteria at most sites, which again is likely to be as a result of the ephemeral low/high flow nature of the streams. This is confirmed by the DO and turbidity levels measured at Violet Creek, which are similar to those measured during the baseline study.

Total zinc, nickel and lead levels occasionally exceeded the ANZECC AND ARMCANZ guideline limits of 3.4 µg/L, 8 µg/L and 11 µg/L, respectively. These exceedances were generally spread across various sites during both the dry and wet season sampling events and were likely the result of runoff from roads and homesteads upstream. During dry season sampling, one site (WQ45) had multiple exceedances of the guideline values. At the time the samples were taken, this site did not contain any flowing water, which likely contributed to the elevated levels.

Copper consistently exceeded the ANZECC AND ARMCANZ limit of 1.4µg/L at most of the sites during both seasonal sampling. While the exceedances were consistent, they were generally marginal with a median level of 3µg/L and an 80th percentile of 4µg/L. Given their moderately elevated levels, it is possible that the higher copper levels result from geological characteristics in the Catchment. This is confirmed by sampling carried out for the Geology, Soils and Landforms Technical Report (Volume 5, Appendix 6), which returned results of up to 42ppm of copper from sites within the mine area.

Nutrients (nitrogen and phosphorus) were both relatively high with the 20th percentiles of Total Nitrogen (TN) and Total Phosphorus (TP) above the QWQG upland streams trigger value. The high N levels are generally a result of kjeldahl (organic) nitrogen. During both dry and wet

Table 7. Summary Baseline Water Quality Results – Upper Belyando Catchment

WATER QUALITY PARAMETERS	UNITS	MINIMUM	20TH PERCENTILE	MEDIAN	80TH PERCENTILE	MAXIMUM
Field/Physical Parameters						
Temperature	°C	21	24.88	25.2	27.84	28.9
pH	Ph Unit	5.9	6.2	6.355	6.72	7.2
EC	mS/cm	0.1316	0.16	0.2375	0.301	0.482
Dissolved Oxygen	%	25	40.6	50	61	76
Turbidity	NTU	1.7	18.4	136	291.4	3185
Laboratory Parameters						
Total Alkalinity as $CaCO^3$	mg/L	15	39.4	73	92	104
Sulfate as $SO4^{2-}$	mg/L	1	1	1.5	3	4
Chloride	µg/L	8000	8800	11000	24200	39000
Calcium	mg/L	2	5.8	11	15.2	16
Magnesium	mg/L	2	3	5.5	7	10
Sodium	mg/L	5	8	9	17.4	38
Potassium	mg/L	5	8	10	10.4	31
Arsenic	µg/L	<1	1.6	2	2	15
Cadmium	µg/L	<0.1	0.2	0.2	0.2	0.2
Chromium	µg/L	<1	4.2	6	19.2	28
Copper	µg/L	<1	2	2	5.4	25
Nickel	µg/L	<1	2	3	5.4	64
Lead	µg/L	<1	3	3	11.4	17
Zinc	µg/L	<5	7.6	9	22	40
Iron	µg/L	<50	1890	4410	6436	13000
Ammonia as N	µg/L	<10	16	25	358	850
Nitrite as N	µg/L	<10	10	10	10	10
Nitrate as N	µg/L	<10	16	20	20	30
Total Kjeldahl Nitrogen as N (TKN)	µg/L	<10	560	800	1280	2800
Total Nitrogen as N	µg/L	<10	560	800	1280	2800
Total Phosphorus as P	µg/L	<10	42	70	178	560
Total Anions	mEq/L	0.72	1.052	1.805	2.28	3.22
Total Cations	mEq/L	0.79	1.138	1.785	2.196	3.3
Chlorophyll a	mg/m^3	-	1.32	1.32	1.32	1.32
PCB	µg/L	<1	4	4	4	10
PAH	µg/L	<1	<1	<1	<1	<1
TPH C_{10}-C_{36} Fraction (sum)	µg/L	<1	<1	<1	<1	<1

season sampling, most sites contained a high level of plant matter. This is a result of the ephemeral nature of the streams which result in flushes of water through the stream during and immediately after summer storm events. During storm events, the creeks and rivers tend to undergo local flooding which picks up plant material from the banks and riparian zone. This material then decomposes resulting in the elevated nutrient levels. This would also explain the several exceedances of the QWQG criteria for Chlorophyll a. TP and TN levels identified through baseline monitoring are generally consistent with the historical data from Violet Grove.

PAHs and PCBs were all below the limit of reporting. Traces of TPHs were detected at several sites during wet season sampling. This may be a result of runoff from the recent rain events collecting hydrocarbons from nearby roads and homesteads. An alternate source of TPHs could be tannins, which are produced from decaying organic matter (e.g. *Eucalyptus* spp. in the riparian areas) may be being washed into the waterways by overland flow during large rain events.

9.5 POTENTIAL IMPACTS

The construction and operation of the mine has the potential to significant impact on waterways in the region. The activities with the highest risk of causing impacts include:

- the clearing of vegetation and topsoils from work sites and stockpiling of overburden on site resulting in sediment movement though overland flow;
- the storage of chemicals on site (e.g. hydrocarbons, detergents and degreasers) during construction and operations and the movement of these to streams;
- the storage, seepage and overtopping of potentially contaminated water such as tailings water or pit process water in dams and basins at the mine;
- the construction and operation of underground mines which may result in subsidence impacting drainage in the immediate area;
- the construction of a water supply dam on Tallarenha Creek;
- the construction of a diversion of Tallarenha Creek/ Lagoon Creek around the eastern side of the mine site. ; and
- potential effects on flooding levels in the region resulting from the creek diversion and operation of the mine.

9.5.1 CLEARING AND STOCKPILES

The clearing of vegetation and construction of mine infrastructure (open cut areas, dams and supporting infrastructure) has the potential to increase sediment deposition in streams offsite. Overburden dumps have the highest potential to impact surrounding streams in the event of large storm events prior to full rehabilitation. Potential impacts include:

- siltation of watercourses and aquatic habitat;
- irregular and unstable land forms due to gully, channel and bank erosion;
- adverse ecological effects from de-silting streams;
- reduced ecology and aesthetic value of streams and riparian vegetation;
- increased turbidity in the streams;
- clogged drainage infrastructure and increased localised flooding;
- silting and bank damage to trench works and drainage structures; and
- increased downtime during construction after storm events while these areas are rehabilitated.

9.5.2 CHEMICAL AND WATER STORAGE

Inappropriately stored and handled chemicals and other hazardous substances have the potential to impact surface waters in and around the mine site during construction and operations. Chemical spills or low-level exposure of the aquatic environment to chemicals (e.g. run-off from machinery, including potential vehicle accidents), would most likely involve hydrocarbon products such as fuels and lubricants. Fuels and chemicals will be stored, transported, handled and used in accordance with relevant legislation, regulations, standards and guidelines. As such, the risk of spillage would be low.

Impacts to aquatic environments during mining operations could also result from seepage or discharge of water containing salts, metals and other potential pollutants from dams and sediment basins located on site. Discharge could occur through failure of dam walls or overflow of weirs into surrounding drainage areas which then make their way into adjacent streams or seepage through the walls and base of the dams into unconfined aquifers which transport the contaminants to surface waters.

9.5.3 UNDERGROUND MINES

The construction and ongoing operations of the underground mines have the potential to cause subsidence directly above the mining areas. Potential impacts would include changed drainage due to ground depressions which may have an effect on the existing hydraulics of surface waters near the mine. The surface water located over the underground mines includes unnamed tributaries of Tallarenha Creek and Lagoon Creek.

9.5.4 TALLARENHA CREEK DAM

- The construction of a dam on Tallarenha Creek will have a number of impacts including:Increase in flood levels for reaches of Beta Creek and Tallarenha Creek upstream of the dam. These will be local effects contained within the mine lease area;
- Sedimentation within the dam reservoir area will reduce the sediment inflows to the Tallarenha Creek diversion channel and sections of Lagoon Creek downstream of the dam; and
- Disruption to fish passage caused by the dam embankment.
- Reduced stream flows downstream of the dam, impacting on flora and fauna that depend on periodic wetting/drying cycles.

9.5.5 CREEK DIVERSION

The diversion of Tallarenha Creek/Lagoon Creek around the eastern side of the mine area will have a number of downstream impacts including:

- Erosion within the diversion channel due to higher flow velocities and reduced vegetation;
- Loss of riparian habitat within the section of diversion channel; and
- Disruption to fish passage due to higher flow velocities.

The creek diversion will only involve a re-alignment of a section of Tallarenha Creek and Lagoon Creek within the mine lease area and will not result in any increase in flood discharges or levels within the waterways downstream of the diversion. The creek diversion will not impact on the flood immunity of any roads outside of the mine lease area. The Mine Site – Jericho access road will cross the creek diversion at the upstream end of the diversion.

9.5.6 FLOODING EFFECTS

It is likely that floodplain encroachment, diversion of flows or impacts associated with drainage structures (i.e. culverts, bridges, etc) may impact on the waterway system as a result of changed flood behaviour. It is therefore crucial that the existing flow conveyance is managed and this can be achieved by incorporating appropriate creek diversion and waterway management practices into the design for the development of the mine site. This may include implementing sediment and erosion control measures and appropriately designed hydraulic structures (culverts, bridges, etc).

Impacts to the waterways may include but are not limited to scour and sedimentation as a result of increased velocities. It is therefore essential that appropriate scour protection measures are incorporated into the design where scour is likely to occur. Possible changes to flood levels may also occur as a result of waterway encroachment, diversion of flows or impacts associated with drainage structure design (e.g. culverts, piers, abutments etc). Waterway crossings are likely to be required for mine access roads as well as the rail connection. It is essential that mine infrastructure is located with due consideration for flooding.

Development of hydrologic and hydraulic models has already been undertaken to determine the existing flood behavior (flow rates and water surface elevations) at the proposed mine development. These models will be utilised to ensure that the mine development incorporates waterway management techniques that protect the waterway systems.

9.6 MITIGATION AND MANAGEMENT

Environmental Management Plans (EMPs) will be developed for the construction and operational phases of the mine. A sub plan will be prepared for surface water issues outlining project specific mitigation measures for each of the potential impacts. Management measures will include:

- the development of a stormwater management plan for the mine that identifies segregation of clean and dirty water catchments, and dams and pumping facilities to ensure that impacted water is contained and re-used on-site where possible.;
- construction of a fishway on the Tallarenha Creek Dam to facilitate fish passage across the impoundment structure.

- design of the Tallarenha Creek/Lagoon Creek diversion to include suitable vegetation and pool/riffle conditions to provide habitat and facilitate fish passage.
- Design of all dams and levees (including flood protection levee on the Tallarenha Creek/Lagoon Creek diversion) to withstand extreme flood events in accordance with the DERM *Manual for Assessing Hazard Categories and Hydraulic Performance of Dams.*
- The development of a monitoring program for the Tallarenha Creek/Lagoon Creek diversion during both the operating and post-closure phases of the mine. This will involve annual (post-wet season) inspections and surveys of the diversion channel to assess the extent and severity of any changes to the physical integrity and geomorphic characteristics of the diversion and downstream waterways.
- the development of an Erosion and Sediment Control Plan (ESCP) for the mine area detailing control measures to be implemented, construction details, dimensions, materials used, expected outcomes and staging of erosion and sediment control once construction is complete. The ESCP will be signed off by the appropriate authority prior to the commencement of works;
- providing appropriate spill control materials including booms and absorbent materials on site and at refuelling facilities at all times in the event that a substance is spilled into the surrounding waters;
- implementing waste management procedures as outlined in Volume 2, Chapter 12;
- ensure trucks transporting fill material to and from the mine are covered at all times and that shakedown facilities are provided at the construction compound;
- ensure all refuelling facilities and the storage and handling of oil and chemicals will comply with the relevant Australian Standards;
- procedures will be established at the mine to ensure safe and effective fuel, oil and chemical storage and handling. This includes storing these materials within roofed, bunded areas with a storage capacity of 100% of the largest vessel and 10% of the second largest vessel. The bunding will have impermeable walls and floor; and
- providing clearly marked wash down areas for plant and equipment.

A water quality monitoring program will be put in place through the Construction EMP. The monitoring program will incorporate the following:

- criteria will be developed with trigger values set at the 20th and 80th percentiles identified through baseline investigations;
- monitoring will include visual inspections of construction areas and surrounding waters;
- physical and chemical water quality monitoring will be undertaken up and down stream of work sites;
  - in the event of an exceedance of any of the trigger values, a response mechanism will be put in place which will include:
  - in the event of an exceedance compare downstream results to upstream results and if the two are similar, any exceedance is unlikely to be a result of the works;
  - if downstream results are noticeably higher than upstream, carry out a visual inspection of the works site to identify potential sources of contaminants; and
  - if no sources can be identified, review construction methods to identify ways of improving works.
- mitigation of hydraulic impacts to natural waterways will be undertaken by:
  - appropriate design of waterway crossings by use of bridge and culvert structures to ensure any impacts on natural waterway behaviour are minimised;
  - incorporation of stream protection works during construction to minimise the likelihood of causing erosion within the watercourses; and
  - ensuring infrastructure are located clear of the predicted flood inundation extents (where practicable).

9.7 CONCLUSION

Baseline monitoring was carried out at nine sites within the mine over two temporal events encompassing dry and wet seasons to account for seasonal variation in water quality. Wet season sampling was carried out during the week subsequent to significant rainfalls from Cyclone Ului.

Field sampling results identified that waterways in the mine area were generally in good health with nutrient and metal levels elevated at some sites during wet season sampling. Most of the streams on the mine are ephemeral and would likely only contain water for short periods during and after the wet season events. This results in a "first flush" event, when contaminants that have built up in pools and adjacent land during the dry season are "flushed" through the system after the first summer rain events.

Construction works that will have the potential to impact on surface waters include:

- the clearing of vegetation and topsoils from work sites and stockpiling of overburden on site resulting in sediment movement though overland flow;
- the storage of chemicals on site (e.g. hydrocarbons, detergents, degreasers, etc) during construction and operations and the movement of these to streams;
- the storage, seepage and overtopping of potentially contaminated water such as tailings water or pit process water in dams and basins at the mine;
- the construction and operation of underground mines which may result in subsidence impacting drainage in the immediate area; and
- the construction of two diversions to Tallarenha Creek from the open cut mine areas.

9.8 COMMITMENTS

Waratah Coal commit to undertaking the following actions:

- develop an ESCP prior to the commencement of construction;
- develop surface and storm water management plans for the mine site; and
- develop an EMP incorporating monitoring requirements for surface waters.