TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

9.1 INTRODUCTION

This chapter provides an assessment of surface waters for the rail component of the Project. The assessment identifies the existing environmental values of surface waters intersecting the rail alignment, assesses potential impacts resulting from construction and operation of the rail and identifies management measures to mitigate the described impacts.

9.2 ASSESSMENT METHODS

9.2.1 DESKTOP REVIEW

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

- online searches of the BOM for climate and flooding data for the study area;
- historical water quality data sourced from the DERM monitoring programs such as the watershed database; and
- 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 2009); and
- published and grey literature including publications sourced from Community Natural resource Management organisations.

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

9.2.2 WATER QUALITY FIELD SURVEYS

Field studies were carried out to determine water types involving the collection of physical and biological data from streams within the study area. Dry (October 2009) and wet (March / April 2010) season sampling comprised field 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.

9.2.2.1 Sample Locations

Field studies were undertaken over two temporal events (dry and wet) to account for seasonal variation in water quality. A total of 19 sites were sampled within the Suttor (10 sites) and Bowen / Bogie Catchments (9 sites). 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 1 and Figure 2.

During field sampling, several of the sites did not contain flowing water therefore could not be sampled. This only occurred during dry season sampling when two of the 15 sites in the Lower Belyando, five of the ten sites in the Suttor and eight of the nine sites in the Bowen / Bogie Catchment contained sufficient water to carry out sampling. During wet season all of the sites contained flowing water providing a total of 17 samples for the Lower Belyando, 15 samples for the Suttor and 17 samples for the Bowen / Bogie.

Wet season sampling was carried out within weeks of 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 200m of the dry season site.

Figure 1. Water Quality Sampling Sites – Northern Section

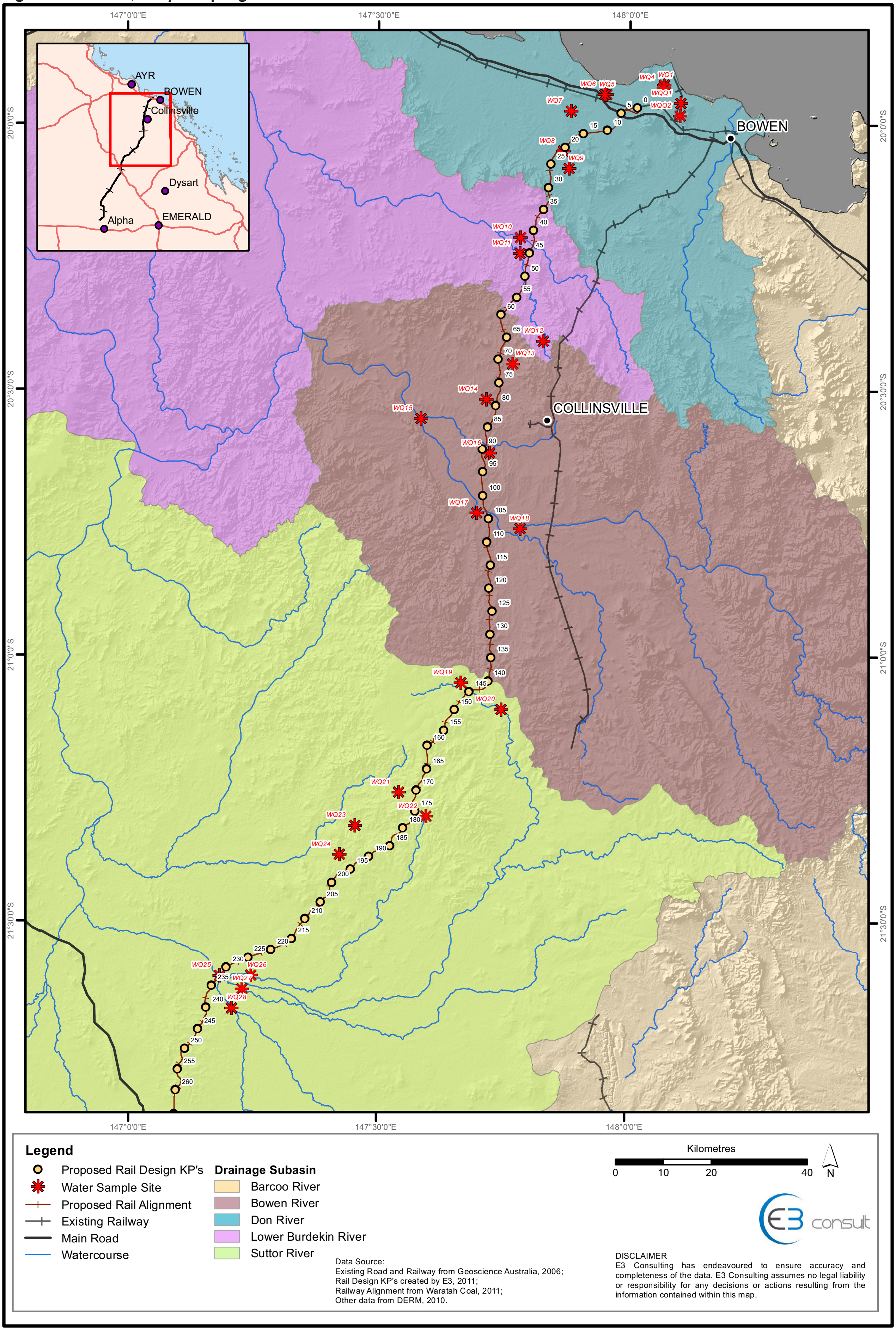
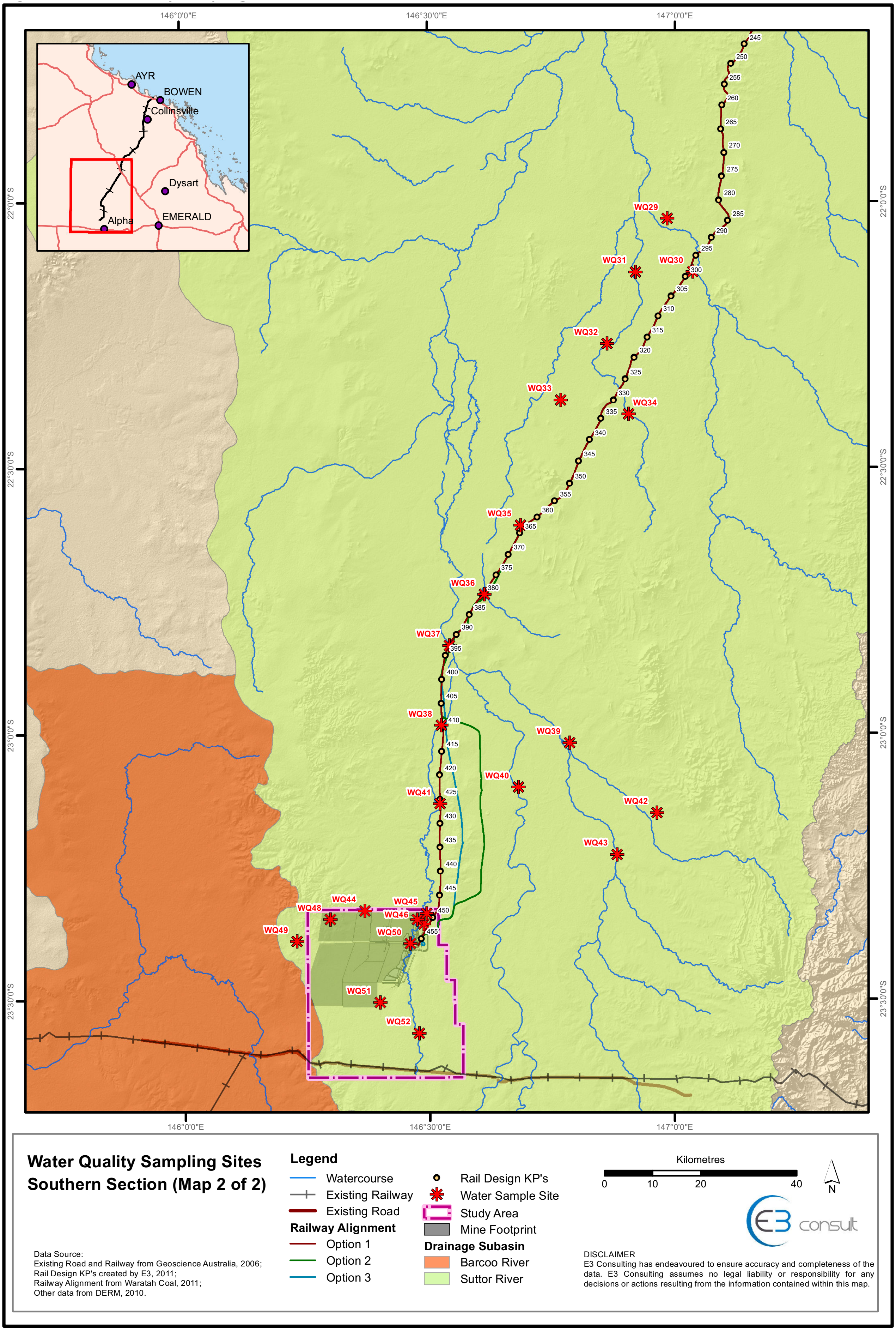


Figure 2. Water Quality Sampling Sites – Southern Section



9.2.3 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 running north from the Burnett River Basin to the Black River Basin, which coincides with the Brigalow Belt and New England Tableland Bioregions (DERM 2009) and encompasses the majority of the study area. Guideline values for the Central Coast Queensland Region are provided in Table 1. The Bowen/Bogie catchment is considered a lowland stream while the Suttor Catchment is considered upland.

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

WATER TYPE	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
Lowland streams	20	500	50	5	85	110	50	10	6.5	8.0	0.31 – 0.81
Upland streams	10	250	30	NA	90	110	25	-	6.5	7.5	0.18

The QWQG does not include values for metals and metalloids therefore ANZECC and ARMCANZ (2000) guideline values for 95% species protection in freshwater have been used for comparison and are listed in Table 2.

Table 2. ANZECC and ARMCANZ (2000) 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

9.2.4 FLOOD ASSESSMENT

An analysis of regional flooding has been carried out at each of the major and a select number of minor waterway crossings along the proposed rail alignment to assess flooding behavior for the existing case (pre-project) condition.

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 flood behavior.

A series of nine XP-RAFTS hydrologic models were created to predict the various catchment responses for use in the hydraulic models developed as part of this study. All nine hydrologic models were simulated for the 10, 50 and 100 year ARI design rainfall events using a range of storm durations to estimate the relevant design event peak flows. Model parameters were derived from record taken during site inspection (including oblique photographic record), review of historical rainfall and gauging station records, and Australian Rainfall and Runoff (AR&R 2001) recommendations.

The proposed rail alignment transects a significant number of creeks and river systems. Previous studies of the major river crossings have been coarse in nature and utilised a one dimensional (1D) steady state modelling approach. In order to provide detailed analysis of flooding behaviour for the major waterway crossings along the rail route, construction of eleven TUFLOW one dimensional (1D) / two dimensional (2D) hydrodynamic flood models has been undertaken. These models were based on the latest detailed Aerial Laser Scanning (ALS) topographic dataset collected as part of this study. Various model parameters have been optimised by use of detailed site photographic record and aerial photography. Where large scale constructed drainage features such as bridges and culverts were evident, these were included in the hydraulic model by way of 1D insert or 2D flow constriction to best represent the structure characteristics and associated impacts on flood behaviour. All of the hydraulic models constructed for this assessment were simulated for the 10, 50 and 100 year ARI design rainfall events.

9.3 DESCRIPTION OF EXISTING ENVIRONMENT

The rail alignment traverses four different catchments, the Belyando, Suttor, Bowen/Bogie and Don. This chapter describes the Bowen/Bogie Catchment (approximately KP30 to KP140), the Suttor Catchment (approximately KP140 to KP270) and the lower reaches of the Belyando Catchment (approximately KP270 to KP468). All three are sub-catchments of the Burdekin with the Belyando and Suttor forming part of the Upper Burdekin and Bowen / Bogie the Lower Burdekin. Characteristics for the three catchments have been described together as topography and land uses and climate do not vary significantly.

The Upper Belyando and Don catchments are described in the mine (Volume 2, Chapter 9) and Coal Terminal (Volume 4, Chapter 2) chapters respectively.

9.3.1 TOPOGRAPHY AND LAND USES

Topography varies over the two catchments with the areas south of Collinsville characterised by low relief floodplains with minor undulating slopes across the Suttor River floodplain. North of Collinsville the terrain becomes steeper across the Leichardt and Clarke Ranges before traversing low lying coastal areas as the alignment approaches Abbot Point.

The Bowen River is cut into the Lizzie Creek volcanic including basalts, andesitic, tuffs and minor acid volcanic and further to the south the Blackwater and Back Creeks Group comprising sedimentary rocks including sandstones, siltstones, shales and coal. Dominant soils in the river valley include dark clays at depth with sandy loam overlying these clays. In the Suttor catchment, the alignment crosses sedimentary rocks of the Suttor Formation and alluvium of the Suttor River derived from these rock types. Dominant soils on the hilly land are shallow, gritty leached sands or sandy loams. The soils of the sloping plains consist of loamy duplex soils to loamy yellow, red and grey earths and cracking clays on the lower areas.

The dominant land use within both catchments is agriculture (grazing) in relatively natural environments such as semi cleared paddocks. In the Bowen/Bogie catchment, an operating coal mine is located adjacent to the rail alignment (near Collinsville).

9.3.2 RIPARIAN CONDITION

9.3.2.1 Lower Belyando Catchment

Riparian areas in the catchment generally consisted of a layer of mature Eucalypts including ironbarks 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.

9.3.2.2 Suttor Catchment

Riparian vegetation density varied across the sites. Most sites had larger tree species (10-35% >10m tall) although two sites (WQ19 and WQ28) had extensive large trees. Four sites had <10% large trees. The majority of sites had some undisturbed vegetation with trees with fairly regular vegetation along both banks; however, sites WQ21, WQ22, WQ26 and WQ28 had highly disturbed riparian vegetation communities. The only site with regular riparian vegetation was site WQ27. All sites except for WQ22 had extensive coverage of trees <10 m, shrubs and grasses. Site W22 was heavily cleared with grasses the only dominant vegetation. Most sites had limited to slight shading.

All streams sampled contained flowing water during the wet season with WQ25, WQ26 and WQ28 (Suttor River, Verbena and Logan Creeks respectively) all flooding at the time of sampling. Streams that hadn't broken their banks were relatively narrow (< 10 m wide).

9.3.2.3 Bowen / Bogie Catchment

Riparian vegetation density was varied across the sites. Most sites had larger tree species (10-35% >10 m tall) although two sites (WQ13, WQ14 and WQ18) had very limited large trees. WQ18 also had several trees within the stream itself. The majority of sites had undisturbed vegetation with trees regular vegetation along both banks. Site WQ10 had undisturbed riparian vegetation communities. All sites except for WQ14 had extensive coverage of trees <10 m, shrubs and grasses. Site WQ14 was heavily cleared with grasses the only dominant vegetation. Most sites had limited to moderate shading depending on stream width.

No sites had banks that were overtopped; however many showed signs of recent flooding such as scattered debris and flattened vegetation. This may have been a result of Cyclone Ului. Soils in the catchment were course compared to the upland catchments (predominantly sands and pebbles.

9.3.3 MORPHOLOGY

9.3.3.1 Lower Belyando Catchment

The streams in the lower reaches of the Belyando catchment (WQ41 to WQ29) were predominantly remnant channels that were flat, low or moderate banked streams. At a number of locations it was not possible to observe the main channel due to the high quantity of water within the stream. In these locations flood channels were observed. The streams ranged from 3 m to 60 m (WQ32) wide although most streams had an observed flood plain that extended up to 25 m either side of the centre of the stream. Site WQ32 had a flood plain of over 2 km wide. Most streams sampled had flowing and pooled water although two streams (WQ35 and WQ38) had significant flowing water (glides >65%) and over half the streams had extensive runs. All streams except for those with high flows also had large pools that covered extensive areas. The majority of the streams had no in stream aquatic plant growth except for site WQ31 that had significant emergent aquatic plants.

Silt was the dominant particle observed at the majority of sites. All the streams had limited bedrock. Erosion varied across the streams with the vast majority having moderate to severe erosion. The majority of streams had partly or very restricted flows due to non-vegetated mid channel bars. Only WQ34 had unobstructed base flows.

9.3.3.2 Suttor Catchment

The streams on the Suttor catchment were predominantly remnant channels that were flat or two staged (stepped) banked streams. Like the lower reaches of the Belyando, at a number of locations, due to the high quantity of water within the stream, it was not possible to observe the main channel, and in these locations, flood channels were observed. The streams ranged from 3 m to 2 km (WQ25) wide although most streams had an observed flood plain that extended from 40 m to 400 m either side of the centre of the stream. Site WQ25 had a flood plain of over 6 km wide. Most streams sampled had flowing and pooled water although two streams (WQ23 and WQ24) had significant flowing water (rapids and riffles >65%) and all the streams had extensive runs. Most streams except for site WQ23 had almost no pools. The majority of the streams had no in stream aquatic plant growth except for site WQ22 that had some submerged aquatic plants.

Silt was the dominant particle in the southern area of the catchment while sand was the dominant sediment in the upper reaches of the catchment. All the sites except WQ24 had limited bedrock. Erosion varied across the streams with the majority having either a stable substrate and/or moderate deposition. Only site WQ24 had observed erosion. The majority of streams were partly to very restricted at base flow with this either being a non-vegetated side channel bars in the upper reaches and vegetated mid channel bars in the lower reaches.

9.3.3.3 Bowen / Bogie Catchment

The streams on the Bowen/Bogie catchments were highly varied in stream shape. Sites WQ14, WQ15 and WQ16 were high and steeped banked streams while the remainder was remnant channels that were broad banked. The streams ranged from 2 m to 80 m (WQ10) wide. Most streams sampled had flowing and pooled water although two streams (WQ10 and WQ12) had significant flowing water (including rapids and riffles) and sites WQ11, WQ12 and WQ16 had extensive runs. The majority of the streams had no in stream aquatic plant growth except for site WQ16 that had moderate aquatic plants.

Sand was the dominant particle in the catchment. All the sites except for site WQ14 had limited bedrock. Erosion varied across the streams with the majority having either a stable substrate and / or moderate / severe deposition. Only site WQ12 had observed erosion. The majority of streams were moderately restricted at base flow by either non-vegetated side channel bars or vegetated mid channel bars.

Currently geomorphic condition which may likely be affected by disturbance or stream diversion via mining and corridor development is available as photographic evidence in Appendix B of the Surface Water Technical

Report – Volume 5, Appendix 15. As a result of this photographic description planning and subsequent monitoring of rehabilitation of watercourses during and post operation is described in detail in Section 9.4 – 9.7 and in the technical chapter.

9.3.4 FLOODING

The variable rainfall and relatively flat topography over most of the alignment can result in localised flooding occurring in floodplains throughout the length of the catchments during events of more than 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 north eastern Queensland coastline.

In January and February 2008, a monsoonal low originating in the Gulf of Carpentaria caused significant rainfalls throughout the region. These falls resulted in a number of the rivers and creeks in the region overtopping their banks, including the Bogie Rivers. Flooding occurred at a number of isolated sites along Bogie Rivers between Charters Towers and Clermont, which includes areas in the vicinity of the proposed railway. This type of event is characteristic of the region where intense rainfall can result in localised flooding of a number of the river and creek systems. Similar conditions were observed in March 2010 following Cyclone Ului that traversed directly over Collinsville as a Category One system. The BOM provides a brief summary of flooding within the Burdekin and Don River Basins whilst a detailed summary of historical flooding from 1950 to present within the Burdekin River and Don River basins has been included in Table 3. General flood summaries for the Burdekin and Don River Basins from the Bureau of Meteorology state 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.

Don River: Since settlement in 1861, historical records indicate that major floods occurred in 1869, 1870, 1884, 1910, 1916, 1918, 1928, 1940, 1946 and 1955. The highest recorded flood was in 1946 with rises to 9.70 metres on the flood gauge at Warden Bend. In recent years, major levels were reached in January 1970, February 1979, January 1980, March 1988, February 1991 and February 2008 (BoM 2010).

Table 3. Flooding History in the Don River and Belyando River basins

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 225mm 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 1952	The 125 to 300mm rains over the eastern central highlands and adjacent parts of the South Coast Curtis district caused sharp stream rises and local flooding in the Dawson, Don and Callide rivers and the upper reaches of the Fitzroy River. One life was lost at Wowan.

EVENT DATE	DESCRIPTION
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.
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 100mm 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 110mm 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].

EVENT DATE	DESCRIPTION
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.
March 1985	During the afternoon of the 14th, minor flooding occurred in the lower Don and Proserpine rivers, decreasing below minor flood levels during the morning of the 15th
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 7.8m 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 10.0m 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 Rive
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, LowerBurdekin, 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 HaughtonRiver as floodwaters broke their banks and flooded many houses and streets of the town in early January.
January 1996	Later in the month tropical Cyclone "Celeste" caused minor flooding on the DonRiver around Bowen. One fatality was reported when a man drowned trying to cross a fast flowing coastal stream near Bowen.

EVENT DATE	DESCRIPTION
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.
August 1998	Don River : The heavy rain of Friday 28th and Saturday 29th resulted in rapid river rises in the Don River upstream of Bowen on the afternoon of the 29th. An initial flood warning was issued at 1510 on 29th for minor flooding throughout the catchment. Flood levels peaked at Bowen Pump Station late Saturday night at 3.25 metres with minor flooding occurring all along the Don River. The flood warning was finalised on the 30th.
February 1999	Don River : Heavy overnight rainfall on the 16th caused rapid rises in the Don River to Bowen. River levels peaked at Bowen on the 16th causing moderate flooding.
December 1999	Tully, Johnstone, Herbert, Haughton and Don Rivers : Heavy rainfall ending on 24 December caused significant river rises in the Tully and Johnstone Rivers. This resulted in moderate flooding in the Tully but the Johnstone River at Innisfail peaked just below the minor flood level. The low pressure system which caused this heavy rainfall moved southward over the new few days and caused significant river rises in most smaller coastal rivers and stream to the NSW border and minor flooding in the Herbert, Haughton and Don Rivers. Flood warnings were finalised by 27th December.
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.
December 2000	At the beginning of December, flood warnings were current for four river basins in western Queensland, as a result of widespread rainfall in November. In the middle of December, more heavy rainfall occurred, again in western Queensland, due to TC Sam with flood warnings issued for six river basins. Flood warnings were also issued for the Don River on the north tropical coast at the end of the month. A total of 103 flood warnings were issued for 8 river basins during December. Don River: Heavy rainfall overnight on the 28 December and the following day resulted in river rises and moderate flooding in the lower reaches of the Don River at Bowen. Flood warnings were issued on the 29 December and finalised on the 31 December.
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.
February 2003	Heavy rainfall occurred in the Capricornia and Southern Highlands during the beginning of the month, resulting in flooding in the Don River of the Fitzroy River system and also the upper reaches of the Burnett River. Rain gradually became more widespread throughout Queensland and flooding occurred in a number of the western rivers.
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
April 2006	At the beginning of the month, storms caused moderate flooding in the Don River. Widespread rainfall in the western part of the State resulted in floods in the Thomson and Barcoo Rivers which extended down to Cooper Creek well into May. Cyclone Monica dumped heavy rain on the Cape and on the North Tropical Coast during the middle of April with flooding resulting in Cape York rivers and most of the coastal rivers and streams from the Daintree to the Tully Rivers. A total of 61 flood warnings were issued for seven river basins during the month. Don River: Very heavy rainfall occurred on the afternoon of Friday 7th April in the Don River with totals up to 150mm recorded in a few hours. As a result, river levels in the lower reaches of the Don River rose sharply causing moderate flooding. The Don River peaked at the Pump Station late Friday night and fell away quickly during Saturday.
January 2008	Don River: Flooding occurred in the lower reaches of the Don River downstream from Ida Creek following a monsoon depression that settled over the east coast between 21st to the 25th. The 72 hour rainfall totals to 9am on 24th of between 90 to 140mm were recorded across the catchment. Minor flood warnings were issued on 23rd and 24th.

EVENT DATE	DESCRIPTION
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 143mm fell on Giru over 2 hours, whilst the heaviest daily rainfall totals exceeded 300mm 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 700mm.
January 2010	Don River: Following the path of Ex OLGA south, the monsoon trough produced moderate to heavy falls in the Don River catchment. A minor flood peak was recorded at Bowen during the morning of the 31st.
March 2010	Severe TC Ului crossed the Queensland east coast near Proserpine early on the 21st of March, 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 6.03m was recorded in the Taroom area.

Source: BOM

9.3.5 EXISTING HYDROLOGY

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, only a limited number of detailed historical records were available for analysis. Operational gauging stations available within the study area that were used to facilitate verification of the hydrologic model results are presented in Table 4. These gauging stations were used to provide verification of the adopted 100 year ARI flows within the Belyando River and Suttor River systems.

Hydrologic modelling was undertaken for the 10, 50 and 100 year 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 at each major watercourse crossing location. Predicted peak flow rates for each ARI event are shown below in Table 5.

Table 4. Gauging Station data summary

GAUGE NO.	GAUGE NAME	YEAR OF PEAK FLOW DATA
120305A	Native Companion Creek at Violet Grove	43
120306A	Mistake Creek at Charlton	23
120304A	Suttor River at Eaglefield	38

Table 5. XP-RAFTS hydrologic modelling results – peak flow summary

CROSSING LOCATION	10 YEAR ARI PEAK FLOW (M^3/SEC)	50 YEAR ARI PEAK FLOW (M^3/SEC)	100 YEAR ARI PEAK FLOW (M^3/SEC)
Mistake Creek	511	1,030	1,329
Lascelles Creek	60	122	158
Sandy Creek	346	717	926
Belyando River	1,439	2,589	3,267
Lestree Hill Creek	47	82	106
Upper Suttor River	291	455	530
Lower Suttor River	6,040	9,340	11,014
Splitters Creek	668	937	1,083
Elliot River	1,180	1,638	1,918
Bogie River	1,300	1,917	2,232
Sandy Creek	440	632	742
Pelican Creek	1,628	2,403	2,780
Bowen River	11,179	16,165	18,501

Existing case (pre project) hydraulic modeling predicted that inundation resulting from design rainfall events varied in extent and depth at each major crossing location. Existing case results are summarised below

9.3.5.1 Caley Valley Wetlands

The Caley Valley Wetlands lie to the south west of the APCT and is the most northern system modelled in this study. The area of interest is bisected by the Bruce Highway and the North Coast Railway and has a flat gradient with a number of minor creeks bisecting the study area.

The low lying floodplain experiences wide spread inundation in the 100 year ARI flood event. The peak depths experienced in Plain and Splitters Creek are greater than 4 m while there are large areas of the floodplain inundated up to 0.8 m. Peak velocities around the major structures associated with the Bruce Highway and North Coast Railway are predicted to be greater than 2 m/s while the peak velocities over the floodplain are generally less than 1 m/s.

Minor inundation of the Bruce Highway near the Caley Valley Wetlands is predicted to occur during events equal to or larger than the 50 year ARI design rainfall event. The adjacent North Coast Railway is also predicted to experience minor inundation during these larger rainfall events; however, the depth of inundation was predicted to be typically less that 50 mm.

9.3.5.2 Elliott River

The proposed crossing over the Elliott River is approximately 22 km from its outlet to Abbot Bay. The Elliot River crossing is characterised by a well defined channel with steep banks. The main channel is heavily vegetated while the overbank areas are only moderately vegetated with a moderate tree cover.

Modelling results for the 100 year ARI event predict depths in excess of 9 m in the main Elliot River alignment while depths of approximately 3 m in the side tributary to the west of Elliot River. The predicted peak velocities within the Elliot River are in excess of 2 m/s while 0.4 to 0.8 m/s is experienced in the overbank areas. The tributary to the west of Elliot River experiences velocities in the main channel between 0.4 and 1.2 m/s along the proposed rail alignment. Flow characteristics in the main watercourse reduce to approximately 8m in the 10 year ARI event, with velocities reduced to approximately 2 m/s.

9.3.5.3 Bogie River

The proposed crossing over Bogie River is 70 km upstream from the confluence with the Burdekin River. The surrounding topography is steep with a deep, well defined watercourse. Bogie River has medium to dense vegetation within the waterway and a consistent vegetation cover to the overbanks. The main channel of Sandy creek is heavily vegetated with some overbank areas shown to be relatively clear and used for grazing.

The results for the 100 year ARI event predict depths in excess of 6 m in Bogie River and 8m in Sandy Creek, with depths of 4.8 m and 7 m respectively during the 10 year ARI event. The predicted peak velocities within the Bogie River are in excess of 2.5 m/s and 2.2 m/s for the 100 and 10 year ARI events while the peak velocities in Sandy Creek are approximately 2.2 m/s and 1.7 m/s for the 100 and 10 year ARI events.

9.3.5.4 Pelican Creek

The proposed crossing over Pelican creek is approximately 15 km south west of Collinsville township and is approximately 17 km upstream from the confluence with the Bowen River.

Pelican River is characterised by a well-defined channel while the tributaries to the north are less defined and results predict more expansive floodplain inundation in these areas. The main channel of Pelican Creek is heavily vegetated while the cleared northern overbank areas are used for grazing. The tributaries of Crush Creek have less defined waterways and the overbank areas have sporadic medium density vegetation with some areas of bare earth.

Model results predict inundation depths of approximately 10.5 m and 9 m for the 100 and 10 year ARI events respectively. Peak depths in the floodplain areas to the north along Crush Creek are predicted to be 0.4 to 0.8 m deep with the main channel experiencing depths greater than 4 m. The predicted peak velocities across Pelican Creek range from 1.5 m/s in the 10 year ARI event up to 2.5 m/s in the 100 year ARI event, whilst lower velocities of between 0.4 to 0.8 m/s are predicted in the floodplain areas to the north around Crush Creek.

9.3.5.5 Bowen River

For the Bowen River hydraulic analysis, the proposed rail alignment was assessed at three locations; Parrot Creek to the south, the Bowen River and a small tributary of the Bowen River to the north. The crossing at the

Bowen River is situated approximately 67 km upstream from the confluence with the Burdekin River. The Bowen River and its banks are densely vegetated while the floodplain to the south is used for grazing and has sporadic moderate density vegetation with some areas of bare earth.

The results for the 100 year ARI event predict depths in excess of 17 m and 6 m in the main channel of the Bowen River for the 100 and 10 year ARI events respectively. Parrot Creek was also shown to have significant flood depths of approximately 12.5 m and 11 m during the 100 and 10 year ARI events respectively.

The predicted peak velocities within the main Bowen River waterway are predicted to be over 6 m/s during the 100 year ARI event, with approximately 5.5 m/s during the 10 year ARI event. Parrot Creek was predicted to have peak velocities in the order of 1 m/s and 0.7 m/s for the 100 and 10 year ARI events respectively.

9.3.5.6 Suttor River (Upper Catchment)

The Suttor River is the main waterway within the Belyando Suttor Sub Basin. This model is located in the very upper reaches of the Suttor River, with the lower Suttor River Crossing occurring approximately 150 km downstream of this crossing location.

The crossing location is high in the catchment and therefore the waterway is well defined and vegetation cover is denser than in many of the other crossing locations.

Model results for the 100 year ARI event predict peak flood depths to be over 8m in some areas. This is due to the well-defined nature of the waterway at this location. Peak velocities are predicted to be approximately 1.5 m/s with some discrete areas above 2 m/s. Depths and velocities reduce to approximately 7 m and 1.3 m/s respectively during the 10 year ARI event.

Results suggest that the well-defined nature of the waterway at this location results in deeper, more defined flood extents, with peak velocities maintained typically under 2 m/s, possibly as a result of the thicker vegetation cover at this location.

9.3.5.7 Suttor River (Lower Catchment)

The Suttor River is the main waterway within the Belyando Suttor Sub Basin. The confluence of the Belyando and Suttor Rivers occurs 35 km downstream of this crossing location.

The crossing is located in a rural / natural area and within a region of the floodplain where a vast number of low flow channels occur within the flat surrounding topography. This in combination with the large flow rates from the large contributing catchment result in expansive flood extents, with a width of 5 km in the 100 year ARI event.

Model results for the 100 year ARI event predict average peak flood depths across the floodplain to be approximately 4 m reducing to 3 m for the 10 year ARI event. Localised channels within the floodplain experience depths of up to 6 m during the 100 year ARI event. Peak velocities are predicted to be on average approximately 1 m/s in the floodplain areas, whilst within the channels near the downstream model boundary where flow is more confined within the channels, velocities are predicted to reach up to 1.5 m/s for the 100 year ARI event.

Results suggest that the Suttor River's large flow rates result in expansive inundation and significant flow depths. Peak velocities would appear to be quite low given the high flow rates, and this is likely due to the flat gradient of the waterway system and the well vegetated nature of the floodplain areas.

9.3.5.8 Mistake Creek

Mistake Creek lies within the Belyando Suttor Sub Basin, and is a tributary of the Belyando River, which it joins 19 km downstream of the crossing location.

The crossing location is in a rural area with regions of cropping and associated dam storages present. This is shown in the flood mapping where a storage reservoir is represented in the topographic data and flood modelling results.

The main Mistake Creek channel is shown to be slightly elevated compared to the surrounding floodplain topography, and as such the modelling results suggest the inundation in the floodplain areas to the north of the main channel are in fact slightly separate from the flows in the main channel itself.

Results predict that peak flood depths in the order of 5.5 m and slightly under 5 m for the 100 and 10 year ARI events respectively in the main Mistake Creek channel. Peak depths of around 2.5 m and 2 m for the 100 and 10 year ARI events occur in the local channels within the floodplain areas to the north of the main channel alignment. Peak velocities are predicted to be approximately 1 m/s for the 100 year ARI event in the cleared floodplain areas where the limited vegetation cover enables faster flow rates. Within the main Mistake Creek channel, velocities are predicted to be in the order of 0.5 m/s for the 100 year ARI event due to the thicker vegetation and flat waterway gradient.

Local catchment flows entering the storage facility were shown to overtop the dam and result in shallow expansive flow downstream of the storage, with depths adjacent to the constructed channel at this location in the order of 1 m for the 100 year ARI event. As no bathymetry data for the storage dam was available for this analysis, depths within the dam itself are unknown.

9.3.5.9 Lascelles Creek

Lascelles Creek lies within the Belyando Suttor Sub Basin, and is a tributary of Mistake Creek, which joins the Belyando River 95 km downstream of the crossing location.

The crossing location is in a rural area and topography at the crossing location is flat with a small number of low flow channels of some 30 m in width that interconnect through the study area. Flood extents are therefore typically shallow and expansive due to the unremarkable nature of the topography.

Model predictions for the 100 and 10 year ARI event suggest peak depths to be in the order of 3 m and 2.5 m respectively in the main channel of the floodplain. Peak depths of up to 1m for the 100 year ARI event were evident in the overbank areas immediately adjacent to the main channel. Peak velocities are predicted to be approximately 0.5 m/s in the cleared floodplain areas whilst within the main channel, velocities are predicted to be up to 1 m/s during the 100 year ARI event. These velocities reduce to approximately 0.25 m/s and 0.7 m/s for the 10 year ARI event.

Results generally suggest that whilst the main channel through the crossing area has higher velocities and deeper flow depths, a significant proportion of the catchment discharge is still conveyed in the floodplain areas due to the small capacity of the main channels.

9.3.5.10 Belyando River

The Belyando River represents one of the main waterway crossings at the southern end of the proposed heavy haul rail alignment. The river lies within the Belyando Suttor Sub Basin, and joins the Suttor River 175 km downstream of the crossing location. The crossing location is in an area where flood behaviour is expansive and interconnects with the adjacent waterway systems (Letree Hill Creek).

Flood depths in the main channel regions of up to 7.5 m and 6.5 m for the 100 and 10 year ARI events respectively are predicted in the main Belyando River channels. Peak velocities within the main channel are predicted to be in the order of 2.5 m/s during the 100 year ARI event reducing to approximately 2 m/s for the 10 year ARI event. In the floodplain areas of the Belyando, depths of approximately 1.5 m are predicted to occur with lower flow velocities of approximately 0.9 m/s during the 100 year ARI event. Flow depth in the floodplain that links the Belyando to the Lestree Hill Creek system are predicted to be in excess of 2 m in some instances with peak velocities of approximately 1 m/s. These values decrease to around 1.5 m in depth and velocities of under 1 m/s during the 10 year ARI event in this region.

Flows in the Lestree Hill Creek system were shown to be small compared to those entering the system from the Belyando River. Extremely small low flow channels are evident in this system and as such most of the catchment runoff is transferred through floodplain areas with depths for the 100 year ARI event varying from approximately 0.5 to 1.5 m. Velocities are similarly low with peak velocities in the order of 0.75 m/s due to the flat nature of the topography.

9.3.5.11 Sandy Creek

Sandy Creek is a tributary of the Belyando River, which it joins 16 km downstream of the proposed crossing location. Three different rail alignment options have been proposed for the section of railway through the Hancock Coal Pty Ltd Alpha Coal Project to the north of the proposed Waratah Coal mine site. Flood modelling has only been undertaken for rail alignment Option 1 which traverses the western boundary of the proposed Alpha Coal Mine. Rail alignment Option 2 traverses the eastern boundary of the Alpha Coal Mine, while Option 3 is through the centre of the Alpha Coal Mine. Rail alignment Options 2 and 3 will involve a crossing of Sandy Creek at a similar location to alignment Option 1.

Existing flooding conditions at the locations of the Option 2 and 3 crossings of Sandy Creek will be similar to those determined for Option 1.

The proposed crossing location (rail alignment Option 1) is in a cleared rural area and flood extents are typically expansive due to the flat nature of the surrounding topography and small channel flow capacities.

Model results for the 100 year ARI event predict peak depths to be in the order of 4 m in the main Sandy Creek channels, with depths of around 1.8 m in the floodplain areas to the north of the main channel alignment. These depths reduce to approximately 3 m and 1 m respectively during the 10 year ARI event. During the 100 year ARI event, peak velocities are predicted to be approximately 2.5 m/s in the cleared floodplain areas where the limited vegetation cover enables faster flow rates. Within the main Sandy Creek channel, velocities are predicted to be in the order of 1.25 m/s due to the thicker vegetation present. Again, these velocities are reduced to 2 m/s and 1 m/s respectively during the 10 year ARI event.

Results generally suggest that for the larger scale events, both the main channel and the floodplain areas adjacent to the main channel carry significant amounts of the catchment discharge, with faster but shallower flow rates in the cleared floodplain areas.

9.3.6 EXISTING WATER QUALITY

9.3.6.1 Lower Belyando Catchment

A review of the DERM historical water quality data indicates that the Native Companion Creek site at Violet Grove is the closest site to the Lower Belyando catchment **(refer to Figure 2)**. This data has been reviewed in the surface water section of the mine component of the EIS **(Volume 2, Chapter 9)**.

Table 6 provides a summary of results from the Belyando Catchment **(Figure 2)**. Results for each site in the catchment are provided in **Volume 5, Appendix 15**.

Table 6. Summary baseline water quality results – Belyando Catchment

WATER QUALITY PARAMETERS	UNITS	MINIMUM	20TH PERCENTILE	MEDIAN	80TH PERCENTILE	MAXIMUM
Field/Physical Parameters						
Temperature	°C	20.80	21.36	23.20	24.34	26.90
pH	Ph Unit	6.40	6.62	6.80	6.88	7.68
EC	mS/cm	0.09	0.13	0.21	0.35	0.52
Dissolved Oxygen	%	23	40	48	75	107
Turbidity	NTU	66	85	114	205	1,159
Laboratory Parameters						
Total Alkalinity as $CaCO^3$	mg/L	28.00	50.00	81.00	103.00	218.00
Sulfate as $SO4^{2-}$	mg/L	1.00	1.00	2.00	2.00	5.00
Chloride	µg/L	4000	6000	11000	17000	25000
Calcium	mg/L	4.00	10.00	12.00	19.80	39.00
Magnesium	mg/L	2.00	3.20	5.00	7.00	13.00
Sodium	mg/L	6.00	8.00	12.00	18.00	37.00
Potassium	mg/L	4.00	6.00	6.00	8.00	18.00
Arsenic	µg/L	1.00	2.00	2.00	4.00	13.00
Cadmium	µg/L	0.10	0.10	0.10	0.10	0.10
Chromium	µg/L	1.00	1.00	3.00	5.00	9.00
Copper	µg/L	1.00	2.00	3.50	5.00	11.00
Nickel	µg/L	2.00	2.00	3.00	5.00	21.00
Lead	µg/L	1.00	2.00	3.00	4.00	12.00

WATER QUALITY PARAMETERS	UNITS	MINIMUM	20TH PERCENTILE	MEDIAN	80TH PERCENTILE	MAXIMUM
Zinc	µg/L	6.00	7.00	8.00	13.00	34.00
Iron	µg/L	480.00	1320.00	2620.00	5226.00	6700.00
Ammonia as N	µg/L	10.00	16.00	28.00	40.00	90.00
Nitrite as N	µg/L	<10	<10	<10	<10	<10
Nitrate as N	µg/L	<10	20.00	30.00	62.00	130.00
Total Kjeldahl Nitrogen as N (TKN)	µg/L	<10	200.00	500.00	800.00	2200.00
Total Nitrogen as N	µg/L	<10	200.00	500.00	820.00	2200.00
Total Phosphorus as P	µg/L	<10	110.00	185.00	360.00	650.00
Total Anions	mEq/L	0.84	1.36	1.82	2.79	4.93
Total Cations	mEq/L	0.90	1.27	1.77	2.60	5.11
Chlorophyll a	mg/m^3	<1	2.2	3	7	47
PCB	µg/L	<1	<1	<1	<1	<1
PAH	µg/L	<1	<1	<1	<1	<1
TPH C_{10}-C_{36} Fraction (sum)	µg/L	50	100	125	228	350

Results for the lower Belyando are similar to the upper (refer to **Volume 2, Chapter 9** of the EIS) and are summarised below:

- 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;
- DO is well below the lower QWQG limits with only three out of the 25 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;
- 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;
- Copper consistently exceeded the ANZECC and ARMCANZ limit of 1.4µg/L at most of the sites during both seasonal sampling, which is likely a result of the geological characteristics of the catchment;
- 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 which is likely a result of the high level of organic material observed in waterways; and
- PAHs and PCBs were all below the limit of reporting while Traces of TPHs were detected at several of the sites during wet season sampling. This may be a result of runoff from the recent rain events collecting petrol and oil spills or decaying matter from the *Eucalyptus* sp. in the riparian areas.

9.3.6.2 Suttor Catchment Water Quality

A review of the DERM water quality data indicates that the Suttor River site at Eaglefield (approximately 20 km south east of KP180) is the only site within the Suttor Catchment where water quality sampling has been historically undertaken (1969 to 2004) **(Figure 2)**. Samples were taken intermittently over this period with many of the parameters having less than six replicates. A summary of the water quality data obtained from this site is provided in **Table 7**.

Table 7. DERM historical water quality – Eaglefield summary

PARAMETER	N	MINIMUM	10TH PERCENTILE	MEDIAN	90TH PERCENTILE	MAXIMUM
EC (µS/cm)	22	30	73	215	379	570
Turbidity (NTU)	5	17	-	-	-	295
pH	6	7.1	-	-	-	8.3
DO (ppm)	5	5.1	-	-	-	11.1
TSS (mg/L)	22	10	20.5	40.5	361.3	910
TN (µg/L)	1	740	-	-	-	-
TP (µg/L)	5	28	-	-	-	160

Table 8 provides a summary of results from the sampling in the Suttor Catchment.

Table 8. Summary baseline water quality results – Suttor Catchment

WATER QUALITY PARAMETERS	UNITS	MINIMUM	20TH PERCENTILE	MEDIAN	80TH PERCENTILE	MAXIMUM
Field / Physical Parameters						
Temperature	°C	19.8	22.72	26.6	30.74	32.7
pH	Ph Unit	5.3	6.3	6.8	7.6	8.06
EC	mS/cm	0.092	0.127	0.207	0.363	0.485
Dissolved Oxygen	%	49	50	63	76	101
Turbidity	NTU	1.3	18	172	417	588
Laboratory Parameters						
Total Alkalinity as $CaCO^3$	mg/L	3	40	50.5	167.6	173
Sulfate as $SO4^{2-}$	mg/L	1	1	2	6	16
Chloride	µg/L	11,000	13,200	21,000	41,800	122,000
Calcium	mg/L	3	4	6.5	17.6	30
Magnesium	mg/L	2	2.2	5.5	9.6	17
Sodium	mg/L	9	16.2	28.5	48	60
Potassium	mg/L	1	2	3	8	13
Arsenic	µg/L	<1	1	2	2.4	4
Cadmium	µg/L	<0.1	<0.1	<0.1	<0.1	<0.1
Chromium	µg/L	<1	2.2	3	4.2	6
Copper	µg/L	<1	2	2.5	4	5
Nickel	µg/L	<1	2	2.5	3.4	4
Lead	µg/L	<1	3	4.5	5	8
Zinc	µg/L	<5	8	8	8	8
Iron	µg/L	160	170	730	1,950	8,980
Ammonia as N	µg/L	<10	20	20	50	280
Nitrite as N	µg/L	<10	10	10	10	10
Nitrate as N	µg/L	<10	20	35	40	80
Total Kjeldahl Nitrogen as N (TKN)	µg/L	<10	340	500	860	1,100
Total Nitrogen as N	µg/L	<10	340	500	920	1,200

WATER QUALITY PARAMETERS	UNITS	MINIMUM	20TH PERCENTILE	MEDIAN	80TH PERCENTILE	MAXIMUM
Total Phosphorus as P	µg/L	<10	74	100	106	150
Total Anions	mEq/L	1.21	1.44	2.05	3.89	5.06
Total Cations	mEq/L	<1	1	3.5	5	48
Chlorophyll a	mg/m³	<1	<1	<1	<1	<1
PCB	µg/L	<1	<1	<1	<1	<1
PAH	µg/L	<50	292	295	298	300
TPH C_{10}-C_{36} Fraction (sum)	µg/L	3	40	50.5	167.6	173

Baseline results from the Suttor catchment show that water quality varies significantly within the Catchment. Generally it is of reasonable quality with the physio chemical properties comparable to the guidelines for *slightly to moderately* disturbed upland streams in the central coast region and historical results from the Eaglefield monitoring station.

Medians for EC and pH fall within QWQG criteria levels. Only the 80th percentile and above for DO are within the guideline range (85% to 110%). All turbidity readings taken in the catchment were below the guideline criteria of 50 NTU. Given the lack of historical data, it is difficult to compare these readings to other areas of the Catchment; however comparison with the QWQG indicates that the streams are generally characteristic of upland streams.

Metals were generally low with median levels within or marginally exceeding relevant guideline limits. Copper marginally exceeded guideline limits at several sites (WQ20, WQ25, WQ26, WQ27 and WQ28) which are likely a result of elevated copper levels in the surrounding geology.

Nutrients levels were elevated with the medians of TN and TP above QWQG criteria. This is the result of large amounts of organic matter being present in the streams due to flushing during and after storm events.

PAHs and TPHs were detected at two sites (WQ20 and WQ25) during dry season monitoring and is likely a result of spills that have occurred in the surrounding area or decomposing plant matter in the riparian areas flushing into the stream after a large storm event.

9.3.6.3 Bowen / Bogie Catchment Water Quality

A review of the DERM historical water quality data indicated that the Pelican Creek site at Coolon Road (approximately 15 km south of KP85) is the only site within the Bowen / Bogie catchments to have historical data (Figure 2). Water quality sampling was only carried out at the site for a year from 2003 to 2004. During this period, parameters were only tested on two or three occasions. A summary of the water quality data obtained from this site is provided in Table 9.

Table 9. DERM historical water quality – Coolon Road

PARAMETER	N	MINIMUM	10TH PERCENTILE	MEDIAN	90TH PERCENTILE	MAXIMUM
EC (mS/cm)	2	0.162	-	-	-	0.185
Turbidity (NTU)	3	1	-	-	-	10
pH	2	7.2	-	-	-	7.4
DO (ppm)	3	4.9	-	-	-	7.2
TSS (mg/L)	2	7	-	-	-	8
TN (µg/L)	3	150	-	-	-	360
TP (µg/L)	3	70	-	-	-	100

Table 10 provides a summary of results from the sampling in the Bowen / Bogie Catchment. Results for each site in the catchment are provided at Volume 5, Appendix 16.

Table 10. Summary baseline water quality results – Bowen/Bogie Catchment

WATER QUALITY PARAMETERS	UNITS	MINIMUM	20TH PERCENTILE	MEDIAN	80TH PERCENTILE	MAXIMUM
Temperature	°C	23.1	26.3	29.4	30.7	32.7
pH	Ph Unit	6.4	7.1	7.6	8.0	8.4
EC	mS/cm	0.002	0.342	0.81	1.17	7.8
Dissolved Oxygen	%	55	59	76	81	107
Turbidity	NTU	1.9	3.9	5.9	26	48
Laboratory Parameters						
Total Alkalinity as $CaCO^3$	mg/L	77	108	151.5	216	242
Sulfate as $SO4^{2-}$	mg/L	3	6	23	136	3080
Chloride	µg/L	20,000	27,400	40,500	260,400	1,040,000
Calcium	mg/L	13	22.4	29	51.8	346
Magnesium	mg/L	9	9.2	16	47.8	428
Sodium	mg/L	23	25.4	42.5	170.2	1,080
Potassium	mg/L	1	1.4	3	6.8	18
Arsenic	µg/L	<1	1	2	8	2
Cadmium	µg/L	<0.1	<0.1	<0.1	<0.1	<0.1
Chromium	µg/L	<1	1.4	2	4.4	6
Copper	µg/L	<1	1	2	3	5
Nickel	µg/L	<1	4.6	5.5	6.4	7
Lead	µg/L	<1	1.6	2.5	4.2	6
Zinc	µg/L	<5	10	10	10	10
Iron	µg/L	90	162	385	3,360	6,980
Ammonia as N	µg/L	<10	20	30	30	40
Nitrite as N	µg/L	<10	<10	<10	<10	<10
Nitrate as N	µg/L	<10	30	40	50	120
Total Kjeldahl Nitrogen as N (TKN)	µg/L	<100	200	300	380	400
Total Nitrogen as N	µg/L	<100	220	400	400	400
Total Phosphorus as P	µg/L	<10	70	110	150	170
Total Anions	mEq/L	2.68	2.95	4.65	14.5	98.2
Total Cations	mEq/L	2.85	2.98	4.79	14	99.8
Chlorophyll a	mg/m^3	<1	3.6	6	9.6	12
PCB	µg/L	<1	<1	<1	<1	<1
PAH	µg/L	<1	<1	<1	<1	<1
TPH C_{10}-C_{36} Fraction (sum)	µg/L	<50	<50	<50	<50	<50

Baseline results from the Bowen/Bogie Catchment show that the streams are generally in good condition with the physio-chemical properties comparable to the QWQG for slightly to moderately disturbed lowland streams in the central coast region and the limited historical results from the Coolon Road monitoring station.

Medians for EC and pH fall within QWQG criteria levels. The 80th percentile and above for DO were the only ones within the QWQG range (85% to 110%). All turbidity readings taken in the Catchment were below the guideline criteria of 50 NTU. Given the lack of historical data, it is difficult to compare these readings to other areas of the catchment; however comparison with QWQG indicates that the streams are generally characteristic of lowland streams.

Metals levels in this Catchment are generally low with minor and isolated exceedances of ANZECC and ARMCANZ (2000) guideline limits. Copper marginally exceeded guideline limits at several of the sites (WQ12, WQ14, WQ15 and WQ16) which are likely a result of elevated copper levels in the surrounding geology.

Nutrient levels in Bowen / Bogie Catchment are also generally low with all TN results below the lowland streams criteria of 500μg/L. TP exceeds the guideline limits from the 20th percentile onwards; however levels are relatively low compared to the Belyando Catchment. PCBs, PAHs and TPHs were below the limit of reporting at all sites in this Catchment.

The lower levels of nutrients, metals and contaminants identified in this catchment compared to the Belyando and Suttor Catchments are likely to be as a result of the more stable nature of the streams and sandy sediments. A number of the streams sampled were perennial and contain flowing water year round while waters in the Belyando Catchment are ephemeral and would likely only contain water for short periods during and after the summer storm season.

9.4 POTENTIAL IMPACTS

During construction and operation of the rail corridor there are a number of mechanisms that have the potential to impact on surface water quality including:

- impacts on vegetation and banks during bridge construction through their removal, causing sediment movement;
- disturbance and stockpiling of soils causing increased turbidity or suspended solids within the water column;
- piling and culvert works for stream crossings;
- use of potentially contaminated / low quality water for dust suppression and other site activities;
- storage of oil, fuel and chemicals on site;
- construction and operational phase water demands; and
- potential effects on flooding levels in the region resulting from the construction of the rail alignment through watercourses and floodplains.

9.4.1 CLEARING AND DISTURBANCE OF SOILS

Construction activities are expected to be relatively invasive, involving extensive excavations including removal of large areas of vegetation in order to create works areas near streams to construct culverts and bridges for crossings. This has the potential to increase sediment loads within the stream as well as nutrients and toxicants associated with the suspended sediment. The stockpiling of topsoils near streams also has the potential to increase sediment loads in streams if not managed properly.

Excavation activities may also result in the disturbance and exposure of ASS in the Don Catchment which can then impact on water quality; however, further testing is to be undertaken to determine the presence and extent of ASS. Potential impacts from ASS disturbance include:

- damage or death of aquatic fauna and flora;
- the release of iron, aluminium and heavy metals into surface water, which reduces water quality;
- damage to infrastructure which is subject to corrosion from acidic water; and
- slumping of structures built on material containing ASS, as this soil type generally has a low-bearing capacity.

9.4.2 PILING

Construction will involve the driving of concrete piles or placement of culverts within the riparian zone and potentially the watercourse itself. These works will result in direct disturbance to the streams, especially for crossings requiring piling or the placement of structures in the stream itself. Potential impacts include the re-suspension of bottom sediments into the water column increasing turbidity and any toxicants present in the sediment. Toxicants in the sediment may include pesticides such as Dichlorodiphenyltrichloroethane (DDT) and its analogues. These have been banned in Australia since 1987; however, the compounds are often found in accumulated in sediments downstream of agricultural lands due to historical use.

9.4.3 RELEASE OF POTENTIALLY CONTAMINATED WATER

Construction of the railway will require substantial quantities of water for dust suppression (not quantifiable at present), landscaping, and surface stabilisation or compaction purposes. Due to the remoteness of large section of the rail alignment, town water supplies may not be available or practical for use. Supply for construction purposes is likely to be sought from non-potable sources such as existing streams, private dams or quarry sites (i.e. the quarry at Abbot Point). Water from non-potable sources may have poor water quality, and if run-off from the construction site occurs at a high velocity, it may contribute to lowering water quality in the catchment.

9.4.4 SPILLS

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.

9.4.5 WATER REQUIREMENTS

High quality (i.e. potable) and low quality water will be required during construction and operational phases. Activities that require lower quality water include:

- moisture conditioning of earthworks;
- dust suppression; and
- vehicles wash down.

Activities that require better quality water include:

- concrete batching; and
- construction campsite and offices.

As long as the construction water does not interfere with the natural waterways there will be no impacts to surface waters.

During the operational phase water supply for operating the rail will be minimal.

9.4.6 FLOODING EFFECTS

It is likely that the filling within the floodplain required for the creation of the railway embankment and the crossings of the major waterways and associated infrastructure will impact on flood behavior. These impacts may include but are not limited to scour in the immediate area of the crossing locations, as well as possible changes to flood levels both upstream and downstream of the rail crossing (afflux) as a result of either the railway embankment or impacts associated with drainage structure design (e.g. piers, abutments etc). Changes to flow regimes in the immediate areas adjacent to the rail embankment are likely due to the change of flow dynamics from the natural pre project environment to constructed crossing arrangements. These impacts are discussed in more detail for each crossing location below.

9.4.6.1 Caley Valley Wetlands

The majority of contributing catchment runoff within the Caley Valley Wetlands area are predicted to be shallow and expansive and natural flow regimes in this area are already impacted by the Bruce Highway and North Coast Railway.

The proposed rail alignment embankment will likely cause a barrier to the shallow sheet flows within the floodplain areas, and concentrate the catchment runoff through the various constructed culvert or bridge crossings.

The concentration of flow to these areas can create additional scour (localised erosion) potential, and can also alter the amount and timing of peak catchment flows entering the environment below the rail alignment.

9.4.6.2 Elliott, Bogie, Bowen, Upper Suttor Rivers and Pelican Creek

These waterways are well defined with significant flooding depths and velocities in some instances. It is likely that these crossings will be bridged, and as such and depending on the respective bridge designs, impacts from the rail alignment may be limited to scour potential around the bridge piers and abutments, and possible increases in flood levels upstream of the rail embankment due to the form losses and blockage associated with the bridge structure.

The effect of the bridges on flow rates downstream of the crossings is not likely to be as significant during lower order events due to the inherent flow transference capabilities of this style of crossing. However, some impact on peak flow rates during flooding events will occur if significant debris build up results in partial blockage of the structure during a flooding event. Blockage of the bridge structures is likely to occur to some extent given the surrounding natural environments at many of these crossings. Blockages of bridges can also lead to increased flood levels upstream as well as impacts on the timing of floodplain peaks within the overall drainage basins.

9.4.6.3 Mistake, Lascelles and Sandy Creeks and Belyando and Lower Suttor River

Waterways which are shown to experience more expansive, shallow inundation across a majority of the floodplain are likely to have a crossing incorporating both earth embankment and bridge / culvert structure. The extent of either the bridge or earth embankment components will be likely dependant on a detailed review of flow rates and flood behaviour at each crossing location.

The likely impact for these crossings is therefore highly dependent on the incorporated flow capacity of each structure, and the extent of earth embankment encroachment into the respective floodplain regions. It is likely that increased scour potential will occur around and through the bridge / culvert region. This is a result of increased velocities through the structure and around features such as piers and abutments. If the earth embankment encroaches into the floodplain significantly, it is likely increased water levels (and depths) upstream of the railway will occur, with a reduced water level downstream of the embankment. Accordingly, impacts on flow transference will occur, possibly resulting in reduced peak flow rates downstream of the rail embankments. This inherently may impact on timing of peak flood levels in regions further downstream in the respective drainage sub basins.

Again, some impact on peak flow rates during flooding events will occur if significant debris build up results in partial blockage of the structure during a flooding event. Blockage of the bridge structures is likely to occur to some extent given the surrounding natural environments at many of these crossings.

Rail alignment Option 1 in the vicinity of the Alpha Coal Mine to the north of the Waratah Coal mine site traverses the floodplain of Sandy Creek and Lagoon Creek. Rail alignment Option 2 and 3 are located further to the west of Option 1 near the divide between the Sandy Creek/Lagoon Creek catchment and the adjacent Native Companion Creek catchment. Rail alignment Options 2 and 3 will have less impact on waterway flooding conditions than Option 1 because the railway will be located on steeper, higher ground than Option 1 which traverses the Sandy Creek and Lagoon Creek floodplain areas. Since Options 2 and 3 will be closer to the catchment divide than Option 1, the waterway catchments crossing the railway between the Sandy Creek crossing and the rail loop will be smaller and accordingly there will be a reduced requirement for cross drainage structures (culverts) and a reduced need to manage impacts relating to flooding and erosion.

9.4.7 OPERATIONAL PHASE IMPACTS

There is little available information about the effect of rail infrastructure on water quality. It is likely that a number of potential contaminants could be released from trains, including oils and lubricants, which could disperse into downstream environments. Such releases could either occur as a result of a single major incident or multiple small releases from the day to day operations of rail infrastructure.

It can be expected that major incidents releasing contaminants into streams will affect aquatic fauna, in particular the sensitive taxa. However, the effects of multiple small releases over extended periods are difficult to quantify and will be highly dependent on the nature of the chemical released.

9.5 MITIGATION AND MANAGEMENT

EMPs will be developed for both construction and operational phases of the rail and will include a Sub Plan for surface water issues outlining project specific mitigation measures for each of the potential impacts. Environmental management measures will include:

- where required, an ASS Management Plan will be developed prior to the commencement of construction which will include the results of detailed site investigations and put in place management measures to reduce the potential for ASS to impacts on surface waters;
- development of a stormwater management plan for the site camps and waterway crossings. These should consider the use of stormwater tanks and re-use of grey water where possible;
- development of an ESCP for the rail alignment 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;
- where works are to be carried out within waterways (i.e. piling for creek crossings) sediment sampling will be carried out to identify potential contaminants;
- When water is present and piling is proposed, vibrocorers should be used where possible in preference to hammer pile drivers to reduce re-suspension of bottom sediments;
- 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 an Chapter 12;
- ensure trucks transporting fill material to and from site 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;
- ensure safe and effective fuel, oil and chemical storage and handling on site. This includes storing these materials within roofed, bunded areas with a storage capacity exceeding the capacity of the storage vessel by 100%; and
- providing clearly marked wash down areas for plant and equipment.

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

- criteria will be developed with trigger values set at the 80th and 20th percentiles identified through baseline investigations;
- monitoring will include visual inspections of construction areas and surrounding waters for evidence of spills;
- physical and chemical water quality monitoring will be carried out up and down stream of work sites for the mine, railway and coal terminal;
  - in the event of an exceedance of any of the trigger values a response mechanism will be put in place which will include a similar structure to the one outlined below:
  - in the event of an exceedance compare down current results to up current. If the two are similar exceedance is unlikely to be a result of the works;
  - if down current results are noticeably higher than up current 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).

9.6 CONCLUSION

Baseline monitoring was carried out at 19 sites within the Suttor (10 sites) and Bowen/Bogie Catchments (9 sites) with field studies being undertaken over two temporal events encompassing dry and wet seasons to account for seasonal variation in water quality. Wet season sampling was carried out within a week of significant rainfalls in the region resulting from cyclone Ului.

Results from the field sampling identified that streams in the study area were generally in good health. Nutrient and metal levels were elevated at some sites during both dry and wet season sampling. This effect was more pronounced in the upland Catchments (Suttor) then the lowland Catchments (Bowen/Bogie). The lower levels of nutrients and metals identified in the lowland Catchments compared to the upland Catchments are likely due to the more stable nature of the streams and sandy sediments.

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

- clearing of vegetation and topsoils from work sites;
- impacts on vegetation and banks during bridge construction through their removal, causing sediment movement;
- storage of chemicals on site (e.g. hydrocarbons, detergents, degreasers, etc) during construction and operations; and
- piling works associated with construction of bridges and culverts at waterway crossings for the railway.

Management measures have been identified to reduce potential impacts resulting from the works. If properly managed the impacts to surface water resulting from the works are expected to be minimal.

9.7 COMMITMENTS

Waratah Coal commit to undertaking the following actions:

- where required, develop ASS management plans and ESCPs prior to the commencement of construction;
- develop storm water management plan prior to construction. This will consider the use of stormwater tanks and re-use of grey water;
- carry out sediment sampling where works are to be carried out within the waterways (i.e. piling for creek crossings and the coal conveyor) to identify potential contaminants including pesticides and herbicides; and
- develop an EMP incorporating monitoring requirements for surface waters.