Surface Water

6

6 Surface Water

This section describes the surface water resources in the Caval Ridge project site, in terms of environmental values and potential impacts and mitigation measures.

The watercourses within the project site include Cherwell Creek, Harrow Creek, Nine Mile Creek, Caval Creek (unnamed watercourse named for project purposes) and Horse Creek, which are tributaries of the Isaac River and part of the Fitzroy River catchment (Figure 6.1). Environmental values of these watercourses include aquatic ecosystems and human uses.

Review of existing water quality data showed that generally the parameters where within the Queensland Water Quality Guidelines (2006) water quality objectives, with the exception of turbidity, pH (slight exceedance), nitrogen & phosphorus. No seasonal variation conclusions were made with the available data set.

A flooding assessment for Cherwell Creek, Harrow Creek, Nine Mile Creek, Caval Creek and Horse Creek was undertaken for a range of flow events up to the 100 year Average Recurrence Interval (ARI). The flood extents for the existing and developed project site have been determined using a hydraulic model.

A qualitative risk assessment approach was used to determine the potential impacts and identify effective mitigation measures through the different stages of construction, commissioning and operation. The potential impacts for the operational phase of the project include: water management system failures, erosion and sediment mobilisation, creek diversions and flooding. These impacts will be managed through appropriate design and maintenance of mine water management infrastructure (sediment basins, pit/process water dams, industrial area runoff dams, flood protection levees, erosion and sediment control measures), and through use of erosion and sediment control, water management strategies, monitoring plans and emergency response procedures.

Total raw water required for project operation is 5,500 ML per annum (17,010 kL per day), which will be used for potable water supply, CHPP make-up water and dust suppression. External raw water will be supplied to the project via a new buried pipeline off-take from the existing Eungella_Bingegang pipeline. The pipeline will follow the Peak Downs Highway to the MIA. Internal raw water supply will be sourced and recycled from the mine water management system.

The proposed mine water management system is a combination of storages (for water collection, treatment and release) interconnected by open channels, and pumps and pipelines used to transfer mine water between storages, to demands and to dewater mining pits. In order to protect the environmental values of the downstream receiving waters, the mine water management system has been designed to: divert clean catchment away from areas disturbed by mining activities; progressively rehabilitate spoil stockpiles; treat runoff from all disturbed areas (haul roads, MIA, etc); and maximise reuse of water from the mine water management system to meet mine demands, to reduce likelihood of off-site discharge and requirement for external water supply.

6.1 Description of Environmental Values

The project site covers tributary streams of the Isaac River in the headwaters of the greater Fitzroy River catchment. The area is divided by a relatively indistinct ridgeline dividing two watersheds: the northern watershed includes Horse Creek and tributaries; and the southern watershed includes Nine Mile Creek, Caval Creek, Harrow Creek, Cherwell Creek and tributaries. Within the project site, Nine Mile Creek and Caval Creek joins Cherwell Creek, and Harrow Creek joins Cherwell Creek downstream of the project site, before joining the Isaac River. Horse Creek joins Grosvenor Creek (Isaac River tributary) downstream of the project site. The local and regional drainage patterns are presented on Figure 6.1.

All watercourses and tributaries within the project site are ephemeral watercourses. Periods of flow are generally short and limited to periods during and immediately after rainfall. There is no evidence of significant contribution to stream flows from groundwater sources.

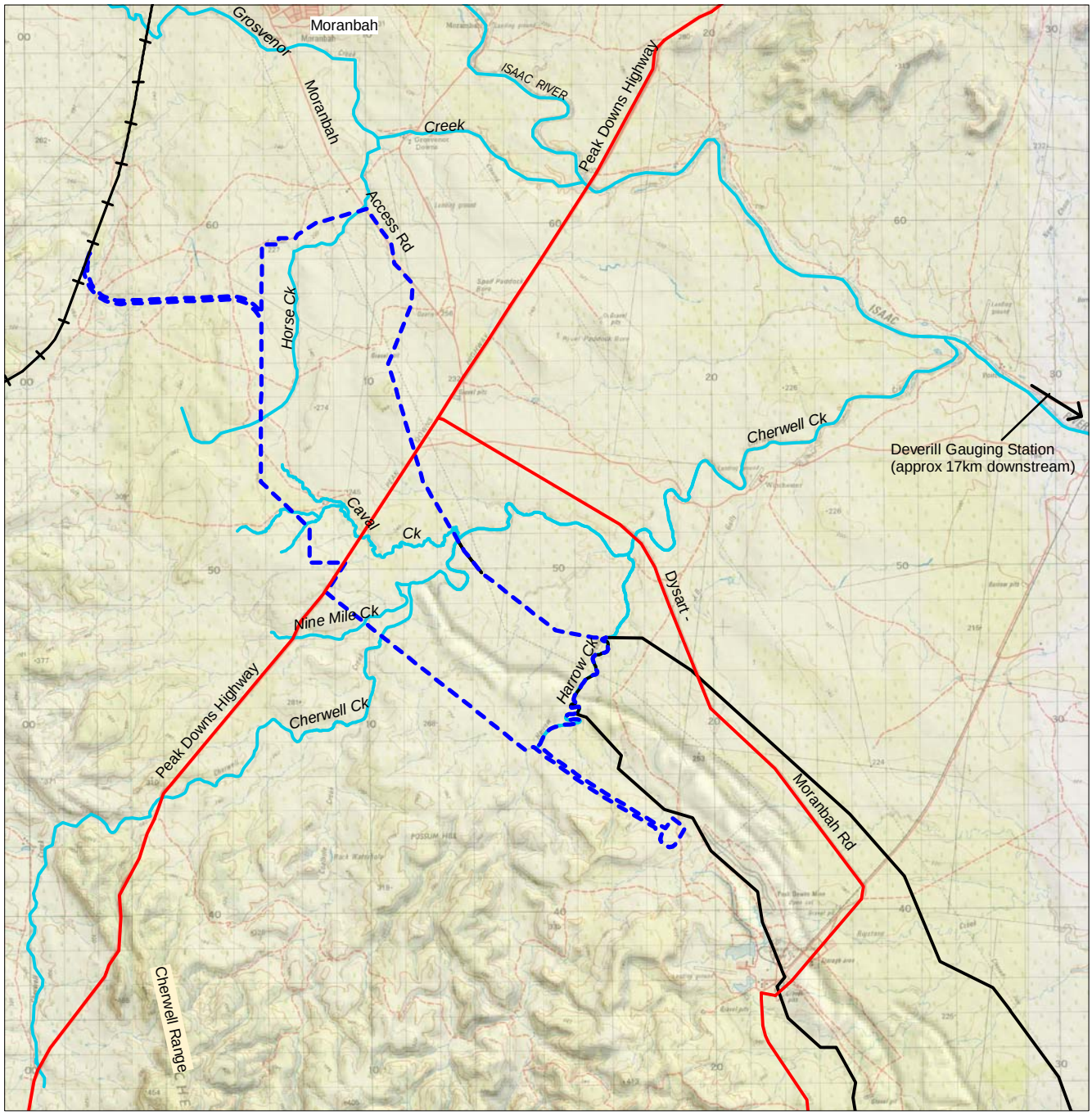
The topography of the catchments within the project site is generally flat to undulating. Elevation across the project site range from 220 mAHD to 274 mAHD, and surface slopes are typically <1% grading to east-north east towards the Isaac River which is the most prominent regional drainage feature (Figure 4.9). The majority of the catchment has been cleared for agriculture (cattle grazing) and several small farm dams have been constructed within the catchment to support these agricultural activities.

6.1.1 Environmental Values

The Environmental Protection (Water) Policy 1997 (EPP Water) and recent Environmental Protection (Water) Amendment Policy (No. 1) 2008 (EPP Water Amendment), are intended to protect and/or enhance the suitability of Queensland's waters for various beneficial uses. The policy and amendment identifies environmental values (EVs) for waters within Queensland and guides the setting of Water Quality Objectives (WQOs) to protect the EVs of any water resource. The EVs include the biological integrity of the aquatic ecosystem and recreational, drinking water supply, agricultural and/or industrial uses.

Within the project site there are five watercourses and various minor tributaries that will be subject to protection under the EPP Water. Specific EVs for Cherwell Creek, Nine Mile Creek, Harrow Creek, Caval Creek and Horse Creek are not defined within the EPP Water and EPP Water Amendment and there are no detailed local plans relating to EVs for the catchment.

Using data gathered from site visits (Appendix I1) and desk top studies, EVs have been identified for watercourses within the project site (Figure 6.1 and Figure 6.2).



0 2.5 5km
Scale

Watercourses
Project Site
Peak Downs Mine
Major Roads

Source: Natmap 1:100000 Series Mapping

Client	Project	Title
BMA BHP Billiton Mitsubishi Alliance	CAVAL RIDGE PROJECT ENVIRONMENTAL IMPACT STATEMENT	**PROJECT SITE DRAINAGE**
URS	Drawn: VH / Approved: RS / Date: 17-05-2009 Job No: **4262 6158** / File No: 42626158-g-505c.wor	Figure: **6.1** / Rev:C / **A4**

Table 6.1 Environmental Values for the Watercourses and Receiving Environment

Environmental Values	Cherwell Creek	Harrow Creek	Horse Creek	Caval Creek	Nine Mile Creek
Aquatic Ecosystem EVs					
Protection of high ecological value aquatic habitat					
Protection of slightly to moderately disturbed aquatic habitat	✓	✓	✓	✓	✓
Protection of highly disturbed aquatic habitat					
Human Use EVs					
Suitability for human consumers of aquatic food					
Suitability for primary contact recreation (eg swimming)					
Suitability for secondary recreation (eg boating)					
Suitability for visual (no contact) recreation					
Protection of cultural and spiritual values	✓				
Suitability for industrial use (including manufacturing plants, power generation)					
Suitability for aquaculture (eg red claw, barramundi)					
Suitability for drinking water supplies					
Suitability for crop irrigation					
Suitability for stock watering	✓	✓	✓	✓	✓
Suitability for farm use	✓	✓	✓	✓	✓

6.1.1.1 Aquatic Ecosystem Environmental Values

The watercourses within the project site are ephemeral in nature and this provides seasonal habitat for aquatic fauna and flora. Further detail is provided in Section 9.

6.1.1.2 Human Use Environmental Values

The surrounding land is currently dominated by agricultural grazing and other mining operations. The primary industry values for Cherwell Creek, Harrow Creek, Caval Creek, Nine Mile Creek and Horse Creek are for stock watering, farm use and industrial use. Further detail is provided in Section 4.5.

Potential other environmental values such as recreational use and industrial water supply are considered unlikely to be of significance due to unreliable and infrequent flows in the ephemeral streams. Potential industrial users of surface water resources in the surrounding area include Peak Downs Mine and Kalari

Workshop. Peak Downs Mine is currently licensed to extract 230 MLpa from Harrow Creek, but is not currently licensed to extract water from Cherwell Creek. Kalari Workshop is not currently licensed to extract water from Horse Creek, and it is unlikely that a sustainable water supply could be provided from this source.

6.1.1.3 Water Act 2000

The Water Act 2000 is legislation for the rights over water resources and their enforcement, the allocation of water, and water planning and investigation in Queensland. Under the act, a watercourse means a river, creek or stream in which water flows permanently or intermittently either in a natural channel (whether artificially improved or not) or in an artificial channel that has changed the course of the watercourse. It also includes the bed and banks and any other element of a river, creek or stream confining or containing water. The drainage channels and streams within the project site all fall under this definition and will be assessed as such.

Under this act, water allocation is regulated under a Water Resource Plan (WRP) and its administration under a Resource Operating Plan (ROP).

It is stated in Section 6.1.3 of the ROP that exemptions apply to allow extraction of mine affected water. Holders of mining tenure (for example, a mineral development licence or mining lease) may make an application for or about a water licence to take water. Any water licence issued would be limited to enabling removal of mine site seepage or runoff that is unavoidably being or proposed to be discharged to a watercourse (Fitzroy Basin ROP 2006).

Cherwell Creek, Nine Mile Creek, Harrow Creek, Caval Creek and Horse Creek and their tributaries will be subject to the Water Act 2000, which will regulate the extraction of water from these watercourses and the diversion of these watercourses.

6.1.1.4 Resource Operating Plan

A ROP defines the rules that guide the allocation and management of water to achieve the objectives set in the WRP. The Final ROP for the Fitzroy Basin was approved in January 2004. A draft amendment to the ROP was released in August 2007, in response to strong growth in parts of Central Queensland, driven by coal mining and associated development, which increased the areas water needs. The amendment provides for:

- Greater flexibility in trading water allocations in the Nogoa Mackenzie Water Supply Scheme.
- Establishing a process for determining a fixed price per megalitre of water for any new water licences in the Lower Fitzroy Area.
- Determination of projects of state significance by the Coordinator-General.
- Including the water release processes associated with significant projects.

6.1.2 Surface Water Resources

All watercourses within the project site are within the Fitzroy basin, which is one of the largest in Queensland, covering an area of approximately 142,500 km^2. It is the largest river basin on the east coast of Australia, and drains to the southern end of the Great Barrier Reef, just east of Rockhampton.

The Isaac River is the major watercourse downstream and to the north east of the project site. It has a total catchment area of 22,470 km^2 (to the confluence with the Mackenzie River) and is a sub-basin of the Fitzroy River Basin.

Grosvenor Creek and Cherwell Creek are two tributaries of the Isaac River in the vicinity of the project site. Grosvenor Creek is to the north of the project site and Cherwell Creek is the southern boundary of the project site.

The project site (Figure 6.1) is approximately 65 km^2 and approximately 50% of the project site drains to Horse Creek, the remainder draining to Nine Mile Creek, Caval Creek, Cherwell Creek, Harrow Creek and their tributaries.

6.1.2.1 Regional Stream Flows

It is estimated that the mean annual flow from the entire Fitzroy catchment to the coast is 7,000,000 ML (ACARP 2000). Watercourses in the north-eastern area of the Bowen Basin, where the rainfall is relatively higher provide a disproportionately higher contribution to the total mean annual flow. The catchment area of the Isaac River is 22,470 km^2 with a mean annual discharge of 2,100,000 ML and a mean annual runoff of 99 mm (ACARP, 2000).

DERM records stream flow in Isaac River at Deverill gauging station (130410A) (Figure 6.1). This is the closest gauging station to the project site, located at latitude 22.173, longitude 148.382, with a catchment area of 4,092 km^2.

Table 6.2 presents mean monthly flows for Isaac River at the Deverill Gauging Station.

Table 6.2 Mean Monthly Flows (1968 and 2007) for Isaac River at Deverill Gauging Station 130410A

Month	Isaac River at Deverill	
	Mean Monthly Flows (m^3s^{-1})	Mean Monthly Flows (ML/day)
January	15.4	1329
February	13.0	1123
March	9.7	844
April	3.9	344
May	2.9	261
June	0.4	31
July	0.1	10
August	1.3	116
September	0.2	15
October	0.4	37
November	1.6	150
December	5.5	505

Typically, mean monthly flows are significantly higher in the wet season between January and March than for the rest of the year (reflecting the higher rainfall totals through this period).

6.1.2.2 Existing Drainage Conditions

All of the watercourses investigated within the project site are ephemeral and formed in alluvial material, meaning they only flow during or after periods of heavy or prolonged rainfall. The watercourses are able to adjust their longitudinal profile (slope), location on the floodplain (platform), and cross-sectional form (width/depth/shape) in response to changes in sediment supply and discharge. The ephemeral rivers in the Bowen Basin are particularly dynamic as a consequence of the highly variable flow conditions. These rivers typically experience prolonged periods of little or no flow between episodic high flow events that can vary considerably in volume and peak flow from year to year (ID&A Pty Ltd 1999).

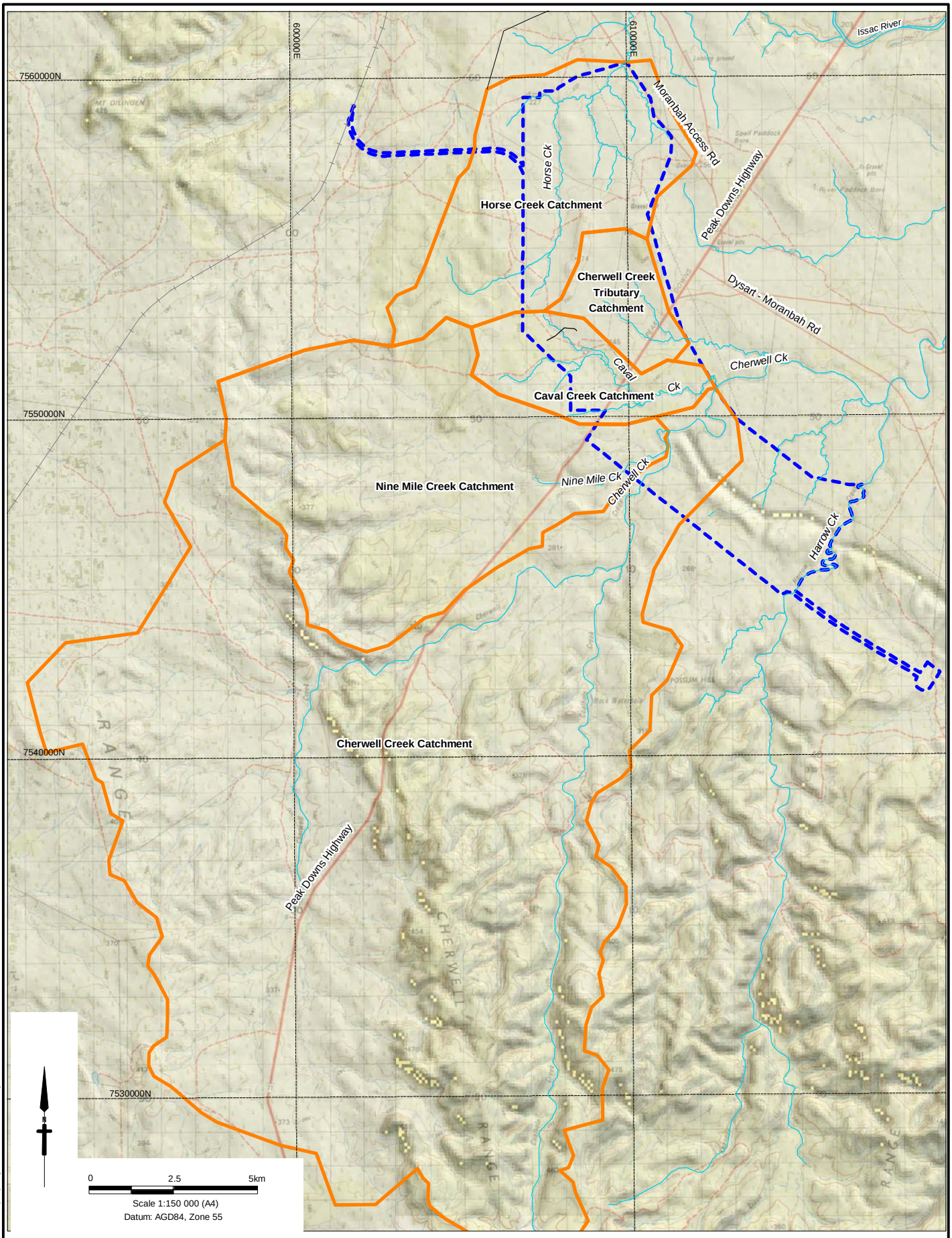
Cherwell Creek

Cherwell Creek, a tributary of the Isaac River, is the most significant watercourse within the project site (Figure 6.2). The Cherwell Creek catchment begins in the Cherwell Range and Denham Ranges at an elevation of 380 m (west of the project site) and flows downstream to join the Isaac River at an elevation of 200 m (east of the project site). Cherwell Creek is approximately 65 km long to the Isaac River junction with a catchment area of approximately 750 km^2. Cherwell Creek and its tributaries have clearly defined channels.

The dominant land use within the Cherwell Creek catchment is beef cattle grazing, with substantial clearing of vegetation having occurred over time to improve pastures. The catchment is not in pristine condition and is susceptible to the impacts of these land use activities, such as increase runoff, scouring, erosion and unstable creek banks.

Cherwell Creek has previously been diverted (in 1991 and 1995) to enable Peak Downs Mine to access coal reserves with open cut pit mining. Both diversions replaced meandering sections of creek floodplain, terraces, benches, low flow channel, active channel, and high flow channel features with relatively straight alignment and trapezoidal channel. The designs were developed in accordance with best practice at the time, which preceded current best practice design guidelines (ACARP 2000). The Cherwell Creek diversions were subject to erosion (channel widening and deepening) and failure of stream stabilisation structures. In 2000, rehabilitation works were undertaken on the diversions. Continual monitoring indicates that the rehabilitation works on the second diversion have been successful however the first diversion continues to erode its bed and banks (Earthtech, 2006).

Within the project site, the natural low flow channel width varies between 15 – 25 m wide and the high flow channel top width varies between approximately 80 – 170 m. The channels are generally deeply incised to a depth of 6 – 8 m. The channel banks slopes are typically 1(V) in 2(H) and vegetated with native long grass and scattered trees. The river bed consists mainly of silty sands. Detailed descriptions of various Cherwell Creek sites are provided in Appendix I1, Sections 1 to 5.



Source: Natmap 1:100000 Series Mapping

Client	Project	Title
BMA BHP Billiton Mitsubishi Alliance	CAVAL RIDGE PROJECT ENVIRONMENTAL IMPACT STATEMENT	**LOCAL AND REGIONAL DRAINAGE PATTERNS**
URS	Drawn: VH · Approved: RS · Date: 08-05-2009 Job No: **4262 6158** · File No: 42626158-g-506b.wor	Figure: **6.2** · Rev:B · **A4**

Horse Creek

Horse Creek, a tributary of Grosvenor Creek, flows in a north, north-east direction through the northern watershed of the project site (Figure 6.2). Horse Creek is approximately 15 km long to the junction with Grosvenor Creek with a catchment area of approximately 57 km^2. The Horse Creek channel is clearly defined.

Fringing riparian vegetation exists along sections of Horse Creek in the vicinity of the project site; however it is discontinuous and contains grasses associated with agriculture. Much of the riparian vegetation along the tributaries of Horse Creek has been extensively cleared and stock access is largely uncontrolled.

Within the project site, the Horse Creek low flow channel base width varies between 2 – 5 m and the channel depth varies between 0.5 – 2 m. The channel banks slopes are typically 1(V) in 2(H) and vegetated with grasses and sparse riparian vegetation, as a result of tree clearing and cattle access. The river bed consists of both silty and gravelly bed material, varying along the creek. Detailed descriptions of various Horse Creek sites are provided in Appendix I1, Sections 7 to 11.

Nine Mile Creek

Nine Mile Creek, a tributary of Cherwell Creek, flows in a south easterly direction through the project site before joining Cherwell Creek (Figure 6.2). Nine Mile Creek catchment area is approximately 72 km^2 at the junction with Cherwell Creek.

Fringing riparian vegetation exists along sections of Nine Mile Creek in the vicinity of the project site; however it is discontinuous and contains grasses associated with agriculture.

Within the project site, the Nine Mile Creek channel base varies between 5 – 20 m and the channel depth varies between 1.5 – 10 m. The channel banks slopes are typically 1(V) in 2(H) and vegetated with large trees and grasses. The river bed consists of sandy bed material. Undermining of the banks occurs as the creek bends. Detailed descriptions of various Nine Mile Creek sites are provided in Appendix I1, Section 6.

Harrow Creek

Harrow Creek, a tributary of Cherwell Creek, flows along the southern boundary of the project site (Figure 6.2). Harrow Creek catchment area is approximately 223 km^2 at the junction with Cherwell Creek.

Harrow Creek was been previously diverted, in 1984 to allow for the expansion of open cut coal mining. Harrow Creek diversion comprises a constructed section of approximately 1 km in length and is bounded by the open cut Heyford Pit to the west and the Harrow Pit to the east. Works have been undertaken as a staged process, with Phase 1 involving lengthening of the upstream channel and Phase 2 involving the rehabilitation of the existing diversion. The presence of bedrock in the channel along with vegetation on the low flow benches encourages stream stability. Revegetation of the diversion was conducted three and a half years ago, resulting in well substantiated grasses along the banks.

The Harrow Creek channel base varies between 5 – 10 m and the channel depth varies between 3 – 15 m. The channel banks slopes are typically 1(V) in 2(H) and vegetated with trees and grasses at the mining lease boundary and predominantly grasses and bushes at the diversion. The river bed consists of sandy silt bed material. Minor undercutting occurs as the creek bends. Detailed descriptions of various Harrow Creek sites are provided in Appendix I1, Sections 1 to 5.

Caval Creek

Caval Creek, a minor tributary of Cherwell Creek and previously unnamed, flows in an easterly direction before joining Cherwell Creek (Figure 6.2). Caval Creek catchment area is approximately 15 km^2 at the junction of Cherwell Creek.

Most sections of Caval Creek are covered with grasses and some trees, however other sections are sparsely covered and are subjected to erosion and this is exacerbated by cattle tracks up and down the banks. The overbanks have grass cover with little riparian vegetation.

The downstream section of Caval Creek is a wide, grass channel since the road crossing further upstream cause the water to back up when it rains.

The Caval Creek channel base varies between 3 – 5 m and the channel depth ranges between very minimal depths to 2 m the river bed consists of course gravel and silt bed material. The channel banks have been undermined at the creek bends.

6.1.2.3 Existing Flood Characteristics

The existing flooding characteristics for the project site were assessed, including Cherwell Creek, Harrow Creek, Nine Mile Creek, Caval Creek and Horse Creek.

Flood Hydrology

The Deverill gauge (130410A) is the closest NRW flow gauging station, located approximately 45 km downstream of the project site (approximately 22 km downstream of the Cherwell Creek and Isaac River confluence) (Figure 6.1).

Due to the location of the Deverill gauge, in relation to the project site, a flood frequency analysis was not undertaken on these gauges to develop peak flows for Cherwell Creek and Grosvenor Creeks. Instead, the Rational Method was adopted to estimate the peak discharges from the watercourses within the project site.

The Rational Method is a probabilistic or statistical method for use in estimating design floods. It is used to estimate a peak flow of selected ARI from average rainfall intensity (AR&R 2001). The Rational Method is the most relevant for this situation as it can be applied when minimal data is available for the site.

Results of the Rational Method peak flows are shown in Table 6.3.

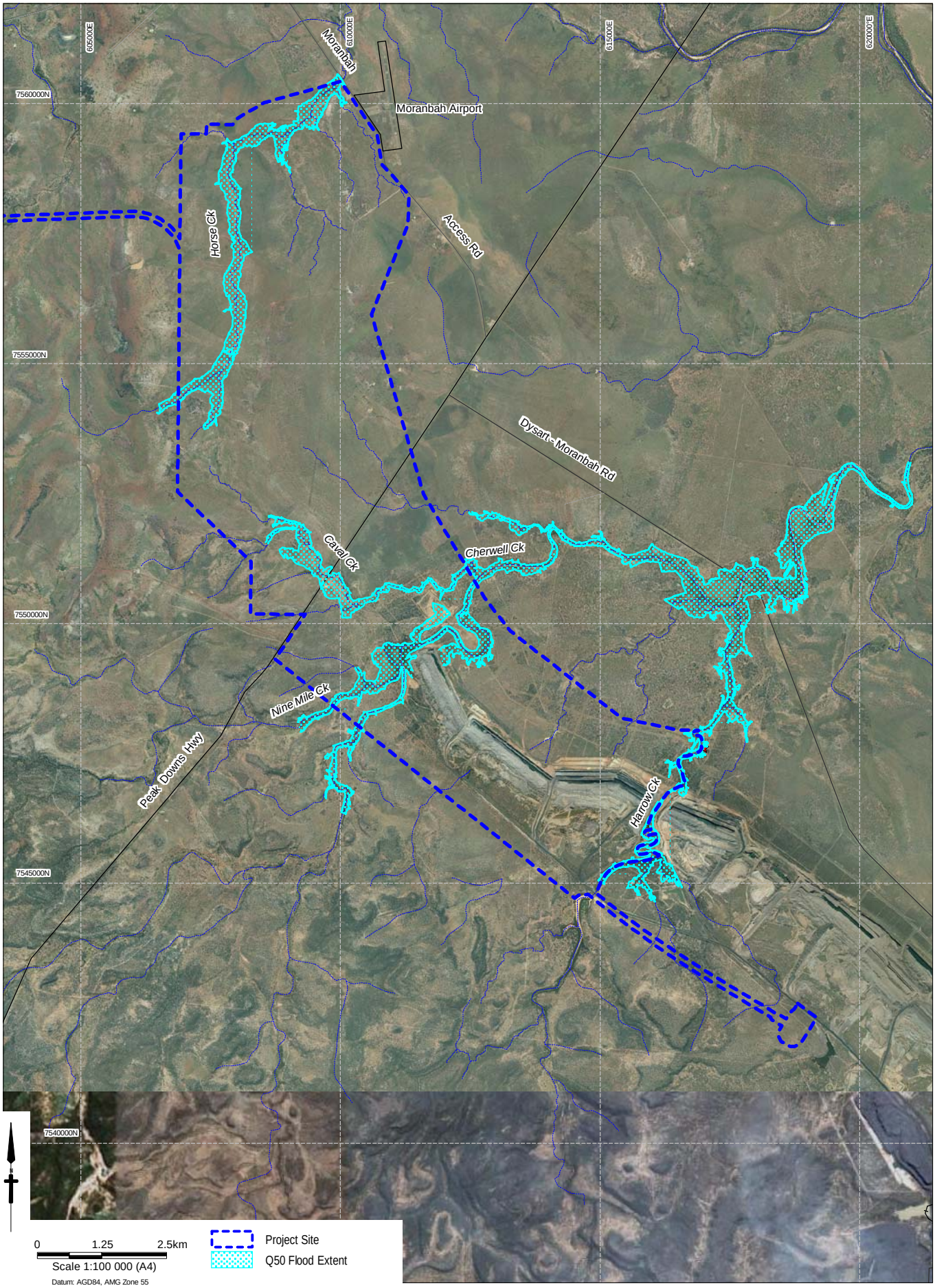
Table 6.3 Rational Method Peak Flows

Catchment	Catchment Area (km^2)	Peak Outflow (m^3/s)				
		Q5	Q10	Q20	Q50	Q100
Cherwell Ck at Isaac Confluence	689	1,475	1,781	2,188	2,788	3,369
Harrow Ck at Cherwell Confluence	223	477	576	708	902	1,090
Nine Mile Ck at Cherwell Confluence	72	154	186	229	291	352
Grosvenor Ck at Isaac Confluence	764	1,635	1,974	2,426	3,092	3,735
Horse Ck at Grosvenor	57	122	147	181	231	279

Flood Assessment

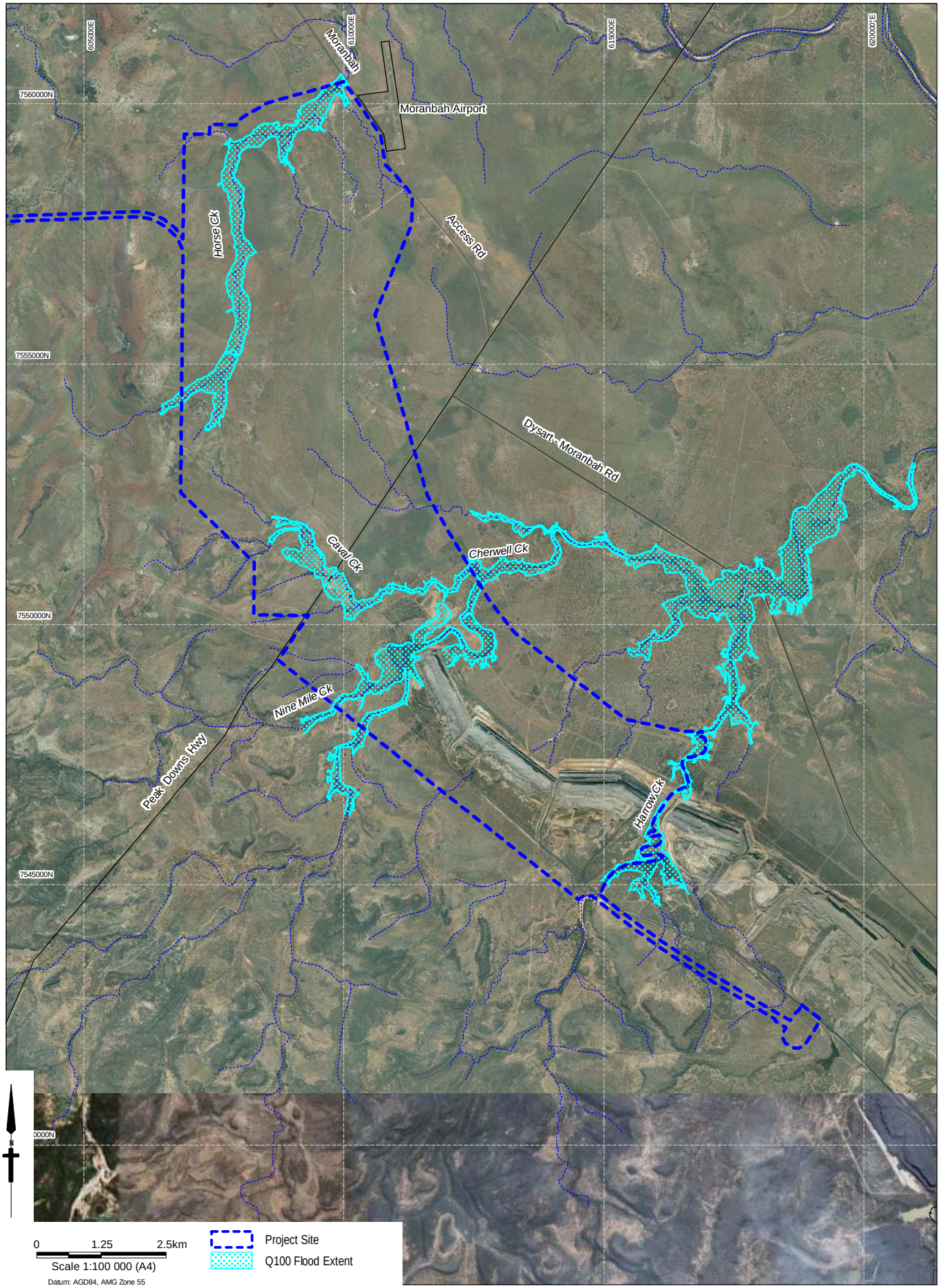
The flood assessment for Cherwell Creek, Nine Mile Creek, Harrow Creek, Caval Creek and Horse Creek has been undertaken using available site survey, combined with publicly available mapping to determine catchment areas. Peak flood flows for a range of flood events up to the 100 year ARI events have been assessed using Rational Method peak flow estimates. Flood hydraulics and flood levels estimates were undertaken utilising the HEC-RAS software which accounts for steady-state, one-dimensional, gradually varied flow. HEC-RAS is produced and supported by the US Army Corp of Engineers, and widely accepted in Australia and internationally for this type of hydraulic analysis. A discussion of the HEC-RAS modelling procedures for the relevant flood events, is provided in Appendix I4, Section 1.

The Q50 and Q100 flood events are shown in Figure 6.3 and Figure 6.4.



Source: BMA Supplied Data

Client	Project	Title
BMA BHP Billiton Mitsubishi Alliance	CAVAL RIDGE PROJECT ENVIRONMENTAL IMPACT STATEMENT	**Q 50 FLOOD EXTENT - CHERWELL AND GROSVENOR CREEKS**
URS	Drawn: VH · Approved: RS · Date: 08-05-2009	Figure: **6.3** · Rev:B
	Job No: **4262 6158** · File No: 42626158-g-525b.wor	**A4**



Source: BMA Supplied Data

Client	Project	Title
BMA BHP Billiton Mitsubishi Alliance	CAVAL RIDGE PROJECT ENVIRONMENTAL IMPACT STATEMENT	**Q 100 FLOOD EXTENT - CHERWELL AND GROSVENOR CREEKS**
URS	Drawn: VH · Approved: RS · Date: 08-05-2009 Job No: **4262 6158** · File No: 42626158-g-524b.wor	Figure: **6.4** · Rev:B · **A4**

Flood Levels and Creek Interaction

Flood levels in Cherwell Creek are controlled by the creek banks. For flow events, up to and including Q100, the flood extents are contained within the creek banks, except at the junction of tributary creeks (Nine Mile Creek, Harrow Creek and Caval Creek), where flood levels extend into the floodplains.

Flood levels in Harrow Creek are generally maintained within the creek banks with the exception of Q100 and above flood events, where the flood waters extend onto the surrounding floodplains.

Flood levels in Nine Mile Creek up to the Q100 are contained within the main channel.

Caval Creek flood levels are contained within the channel banks, except at the junction of Caval and Cherwell Creek.

The upstream section of Horse Creek contains all flow events up to and including the Q100.

Model Verification

The flood level results predicted from the base case HEC-RAS model were compared with the results from previous investigations and anecdotal information and were found to be consistent with these. As the objective of the flood assessment was to compare the base case and the future case scenarios, this level of model verification is fit for purpose.

6.1.3 Existing Water Quality

6.1.3.1 Guidelines

The Australian and New Zealand Environment and Conservation Council Guidelines 2000 (ANZECC) provide guideline values or descriptive statements for environmental values to protect aquatic ecosystems and human uses of waters (e.g. primary recreation, human drinking water, agriculture, stock watering). The ANZECC Guidelines are a broad scale assessment and it is recommended that, where applicable, locally relevant guidelines are adopted.

The Queensland EPAs Queensland Water Quality Guidelines 2006 (QWQG) are intended to address the need identified in the ANZECC Guidelines by:

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

Relevant water quality objectives for the project site were identified from QWQG to support and protect different environmental values for waters in the upper Fitzroy River Catchment. The physico-chemical indicators were obtained from the Central Coast Region upland stream values. Salinity guidelines were obtained from Appendix G of the QWQG.

6.1.3.2 Existing Conditions

Central Queensland's water quality assets are under pressure from poor ground cover, land clearing, water contaminants, invasive plants and animals, modification of riparian zones, floodplains and wetlands, stream bank erosion, waterway development, barriers to species movement and cost of changing management practices (FBA, 2000).

Policies/programs being developed in Central Queensland for water quality include:

- The Fitzroy Basin Association, a community-based organisation that promotes sustainable development in Central Queensland, are working towards the setting and refining of water quality targets related directly to implementation of on-ground actions.
- The Policy for the Maintenance and Enhancement of Water Quality in Central Queensland. This provides a non-regulatory collaborative planning and management of water quality by all key stakeholders in the region. The policy was initiated by the Fitzroy Basin Association (FBA) and the Central Queensland Regional Planning Advisory Committee (CQRPAC).
- A flood based sediment and nutrient monitoring program is being funded through the National Action Plan for Salinity and Water Quality and more recently co-funded by the National Landcare Program.

High turbidity values are common within the Fitzroy River catchment, with measured turbidity levels exceeding both ANZECC (1992) and NHMRC (1996) targets, rendering the water unsuitable for drinking purposes and for the protection of aquatic ecosystems. This is most likely related to a combination of factors, including the region's soil type, agricultural land use, and mining activities. However, trend analysis indicates that there has not been a significant increase in turbidity levels in the last ten years, suggesting that the observed elevated turbidity levels may also be strongly dependant on the basin's soil type and topography (ANRA 2007).

6.1.3.3 Water Quality Analysis

The existing water quality of the watercourses and downstream receiving environment of the Caval Ridge project site was assessed to characterise the baseline water quality conditions. The assessment was based on a review of existing water quality monitoring data and monitoring undertaken as part of this EIS.

Detailed ecological assessment of the site is included in Sections 8 and 9.

Methodology

Physico-chemical parameters for watercourses within the project site were assessed using results gathered from three sources:

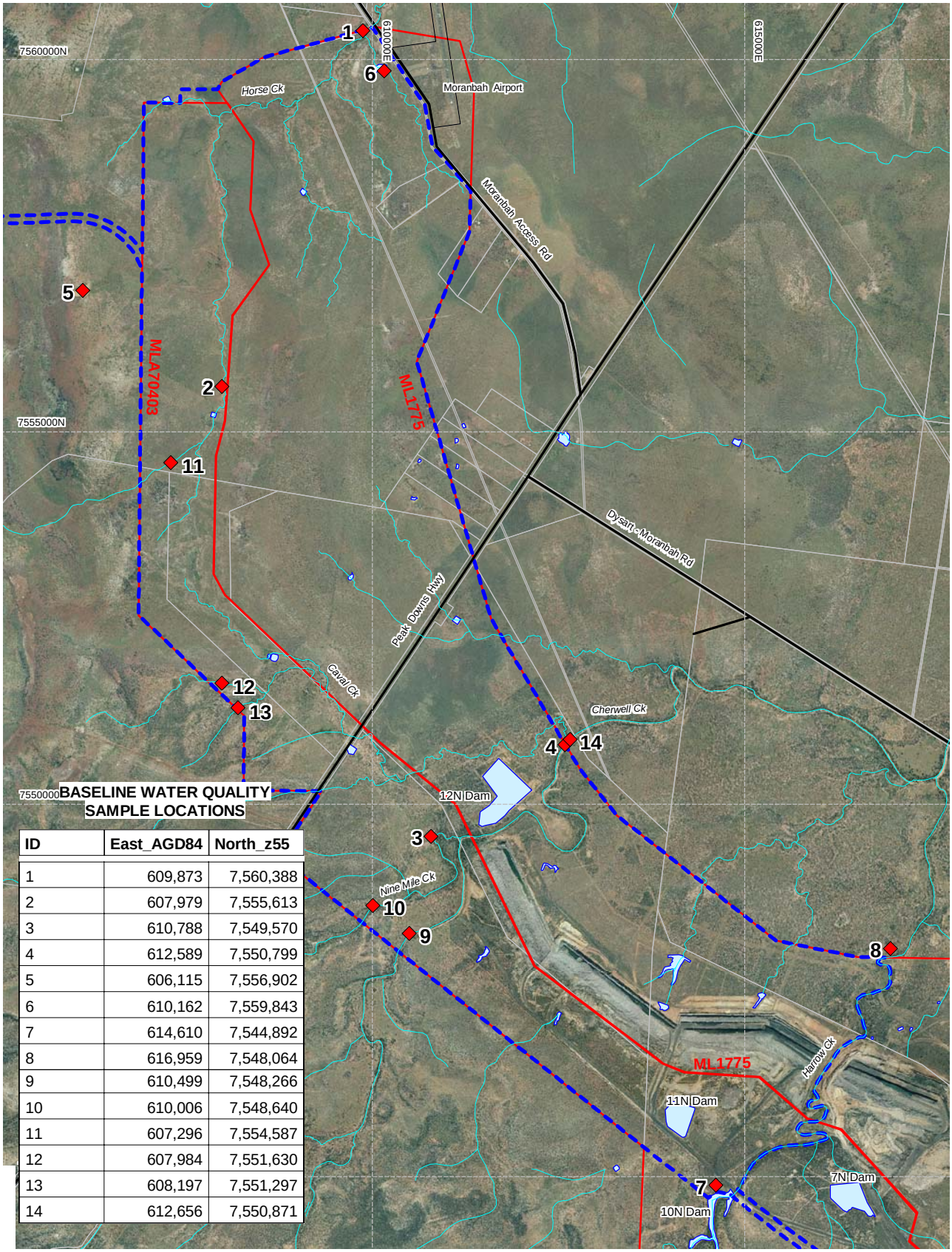
- Water quality monitoring activities were undertaken by Bureau Veritas in January, February, March and August 2008. Samples were taken where possible at watercourses at eight different sites (Figure 6.5) during periods of flow within the watercourses following rain events. Sites sampled by Bureau Veritas were:

  - Cherwell Creek (Site 4)
  - Nine Mile Creek (Site 3)
  - Horse Creek and its tributaries (Sites 1,2,5 and 6)
  - Harrow Creek (Site 7).
- Water quality data sourced from BMA was limited to samples taken between January 2007 and May 2008. Sites sampled by BMA were:
  - Cherwell Creek.
  - Harrow Creek.
- Water quality data was obtained from DNRW at Isaac River at Deverill gauging station located upstream of the project site (Sampling events from 1964 to 2000).

Refer Appendix I5 for the water quality data set from these sources.

Results

This section outlines the results obtained from the water quality monitoring. Table 6.4 provides the median values for each of the monitoring locations. Refer Appendix I5 for the raw data set.



BASELINE WATER QUALITY SAMPLE LOCATIONS

ID	East_AGD84	North_z55
1	609,873	7,560,388
2	607,979	7,555,613
3	610,788	7,549,570
4	612,589	7,550,799
5	606,115	7,556,902
6	610,162	7,559,843
7	614,610	7,544,892
8	616,959	7,548,064
9	610,499	7,548,266
10	610,006	7,548,640
11	607,296	7,554,587
12	607,984	7,551,630
13	608,197	7,551,297
14	612,656	7,550,871

0 1 2km

Scale 1:75 000 (A4)

Datum: AGD84, AMG Zone 55

Water Sampling Locations

Project Site

Mining Lease

Source: Client Supplied Data

Client

BMA

BHP Billiton Mitsubishi Alliance

URS

Project

CAVAL RIDGE PROJECT
ENVIRONMENTAL IMPACT STATEMENT

Title

BASELINE SURFACE WATER QUALITY SAMPLING LOCATIONS

Drawn: VH | Approved: RS | Date: 08-05-2009

Job No: **4262 6158** | File No: 42626158-g-515.wor

Figure: **6.5**

Rev:A

A4

Table 6.4 Baseline Water Quality- Median of Sample Results

Sample	EC (µS/cm)	Turbidity (NTU)	pH	TSS (mg/L)	TN (µg/L)	Organic N (µg/L)	NH_4 (µg/L)	TP (µg/L)	Chlorophyll-a (µg/L)	DO (% sat)
8N Harrow	690		8.3							
Harrow Ck	857		7.8							
Harrow Ck DS	554	5	7.8							
Harrow Ck US	461	16	7.5							
Harrow Ck Pipe		2								
Harrow Ck BAR	130		6.3							
Cherwell Ck	217		7.7							
Cherwell Ck US	333		7.6							
Cherwell Ck DS	295		7.5							
Site 1	270	136	7.6	39	500		101	170	2	
Site 2	320	240	7.7	88	3200		267	215	12	
Site 3	1139	3	7.3	22	1,450		22	35	1	
Site 4	293	1	7.9	24	1,100		29	45	1	
Site 5	248	240	7.2	52	2,400		201	465	1	
Site 6	220	246	8.6	56	800		76	250	2	
Site 7	448		7.9		620		100	20	16	
Isaac River Deverill	269	74	7.7	128		1,114	24	158	10	82
QWQO	720	25	6.5-7.5	Na	250	225	10	30	Na	90

Table Notes:

NH_4 = Ammonia N TP = Total Phosphorus DO = Dissolved Oxygen

TN = Total Nitrogen TSS = Total suspended solids EC = Electrical Conductivity

The available water quality data indicates that turbidity values are above the QWQG water quality objectives at Isaac River gauging station and the majority of the upstream and downstream sites.

Dissolved Oxygen (DO) levels were analysed only at Isaac River gauging station and were found to be below the water quality objectives. DO should preferably be sampled during and immediately after flow events. Water within stagnant pools can naturally experience low DO values and it is unknown how the river was flowing at the time of sampling.

pH results in the available data indicate slight exceedance of the QWQG water quality objectives for upland streams in the central coast region.

Salinity

Salinity has traditionally been a varied issue within the Fitzroy basin and has been associated with land degradation, soil erosion, tree clearing and the overuse of groundwater supplies (FBA, 1996). The median electrical conductivity (EC) is within the water quality objectives at the majority of sampled sites.

Nutrients

Information in Table 6.4 indicates that TN exceed the water quality objectives at all sites, and TP was exceeded at all of the sites with the exception of site 7. As these sites are located on cleared land for cattle grazing it is expected that these elevated nutrient values are a result of manure, fertiliser and a lack of riparian vegetation buffering and filtering the runoff into the watercourses. Upstream land-uses may also be contributing to these concentrations. The inorganic N (NH_4) concentrations are substantially lower than the organic N concentration which indicates a high proportion of nitrogen coming from organic sources.

Total Petroleum Hydrocarbons

Total Petroleum Hydrocarbons (TPHs) were tested for and broken down into specific fractions. The surrogate extraction levels for the TPHs were all within the control limits. Refer Appendix I5 for TPH analysis results.

Metals

The median metal values obtained were compared to ANZECC trigger values for toxicants at 95% level of protection for freshwater aquatic species. Besides slightly elevated aluminium levels at Harrow Creek and Cherwell Creek, all other concentrations were within the QWQG. Refer Appendix I5 for metal analysis results.

No other parameters had elevated values.

Seasonality

Rainfall averages suggest a distinct wet and dry season, with the majority of rain falling between December and February. However due to the ephemeral nature of the watercourses in the area, no sampling was possible during the dry season due to the lack of rain and therefore flow in the watercourses. Without a larger data set no water chemistry conclusions regarding seasonal variation have been made. However, it can be said that any flow within these creeks is rare during the dry season.

6.2 Potential Impacts and Mitigation Measures

The following section details the major planned activities for the project, through the different stages of construction, commissioning and operation. The potential impacts are discussed and management measures to minimise those impacts are outlined. This was undertaken using a qualitative risk assessment approach (Appendix I3). Risk is the chance of something happening that will have an impact and it is

measured in terms of the potential consequences of an event and the probability factor i.e. likelihood that the event will occur (in accordance with the BMA Job Step Analysis Assessment Guide (BMA, 2005)). The detailed risk matrix for the Caval Ridge Surface Water activities is provided in Appendix I3 and the impacts and mitigation measures identified are outlined as follows.

From the BMA Job Step Analysis Assessment Guide (BMA, 2005), each inherent risk is measured for consequence and probability factor and an associated risk is assigned. For each aspect of construction, commissioning and operation, mitigation measures are assessed and a residual risk is re-assigned to reflect the remaining risk following implementation of the mitigation measures.

6.2.1 Construction Phase

Construction of the Caval Ridge Mine is expected to commence in 2010 with the first coal extracted in 2013. The peak workforce numbers during construction is expected to be approximately 1,200 people. This will decrease to around 495 people during operation. The construction phase will include:

- Construction of surface infrastructure, including:
  - Haul roads
  - Coal preparation plant
  - Box cut
  - MIA (including workshop and administration building)
  - Rail spur, loop and loadout facilities
  - ROMs
  - Overland conveyor
  - Raw and product coal stockpile pads.
- Construction of mine water management infrastructure (including sediment basins, pit/process water dams, industrial area runoff dams, levees, drains, pipelines and creek diversions).
- Construction activities (and Operation activities – refer to Section 6.2.3) which result in sediment and contaminant mobilisation may have negative effects on water quality. This may result from increased levels of hydrocarbons, TSS and turbidity within the watercourse, resulting in exceedances in water quality objectives. All mitigation measures discussed below and further detailed in Appendix I3 are aimed at maintaining and/or improving water quality within the creek system.

6.2.1.1 Earth Moving Activities

Earth moving activities are expected to be required for all of the construction activities listed include:

- Removal of vegetation
- Top soil removal and stockpiling

- Earthworks including cut and fill and compaction
- Trenching for teeing into the Eungella- Bingegang pipeline.

Potential Impact

Sediment mobilised during construction activities may enter surface water runoff during rainfall events and discharge to watercourses leading to deleterious effects on water quality.

Sediment exposed or generated during construction may also be blown by wind into surface water bodies and potentially dry up wet areas. This may be an issue during construction due to the crossing of a number of watercourses.

The qualitative risk assessment identified this potential impact as a high inherent risk (could easily happen, with minor effects on biological or physical environment). Refer to Appendix I3 for further details.

Mitigation Measures

The earthworks contractor will be required to prepare a construction environmental management plan which will include a sediment and erosion control plan and water management plan prior to the commencement of construction. These plans will include the following mitigation measures:

- Erosion control, energy dissipation and watercourse stabilisation such as matting, riprap and gabions: areas of disturbed or exposed soil will be managed to minimise the loss of sediment, either through revegetation and/or use of other stabilisation techniques. Bunds to restrict flow velocities across the project site will also ensure that risks are minimised.
- Stormwater controls and upstream treatment, such as infiltration devices and vegetation filters.
- Stabilisation techniques, such as re-vegetation: work will be concentrated in as small an area as possible and progressively expanded to reduce the area potentially at risk.
- Specific construction activities will only be undertaken during the dry season: no clearing work will be carried out during heavy rainfall.
- Stockpiling of topsoil and other material located away from watercourses: usable topsoil will be stripped and stockpiled away from drainage lines to protect it from erosion.
- Minimise vegetation disturbance, especially riparian vegetation: a minimum number of passes by heavy earth moving equipment will also help to minimise erosion and dispersion of soils by the wind. Additionally, upon completion of works, revegetation using local species will take place wherever possible and as soon as practicable considering seasonal influences.
- Routine inspection of sediment control devices.
- Any release of water from sediment basins to receiving waters, will be tested for quality and ensured that it meets water quality objectives.
- Ensure there is an adequate supply of water for dust suppression.

- To limit sediment mobilisation, the existing sediment control structures (e.g. farm dams and Peak Downs Mine water management system) will be used.

The qualitative risk assessment identified that the application of the above proposed management measures reduces the residual risk to a low risk (has not happened yet but could, with minor effects on biological or physical environment). Refer to Appendix I3 for further details.

6.2.1.2 Works Adjacent to/within Drainage Lines

Works adjacent to or within drainage lines are expected to include:

- Haul road, back access road and dragline access creek crossings;
- CPP and MIA
- Railway spur and loop
- Creek diversions
- Trenching for connection to the Eungella- Bingegang pipeline.

Potential Impacts

Construction activities at drainage lines and watercourse crossings and vehicle access crossings can mobilise sediment and alter flow and quality characteristics.

The qualitative risk assessment identified this potential impact as a high inherent risk (could easily happen, with minor effects on biological or physical environment). Refer to Appendix I3 for further details.

Mitigation Measures

These potential impacts will be mitigated by ensuring:

- Construction activities that will affect existing drainage lines and control measures will only be carried out after suitable stormwater management infrastructure has been installed onsite – as per the construction contractor's environmental management plan.
- Vehicle crossings will be adequately designed for a range of flow conditions, including under road drainage.
- The temporary diversion of watercourses will be either by low flow diversion or coffer dam with pumping.
- Disturbance by heavy earth moving equipment will be minimised especially in riparian areas.
- A minimum number of passes by heavy earth moving equipment and creek crossings will also help to minimise the affect to the surface water bodies and drainage lines.
- All crossings will be in accordance with the DERM Guideline – Activities in a watercourse, lake or spring carried out by an entity.

A Riverine Protection Permit is required for the Peak Downs Highway and as a minimum will require the following mitigation measures as conditions of the Riverine Protection Permit. Specific management measures and conditions relating to each watercourse will be established by DERM.

- The area of disturbance must be no greater than the minimum area necessary for the purpose.
- The area of bed and banks disturbed by the activities must be stabilised regardless of previous stability.
- The extent and duration of bare surface exposure must be minimised, and protected from weathering, rain drop impact, and water runoff.
- Clean water run-off must be diverted around areas of disturbance where practicable.
- Bed and bank stability must be managed to minimise erosion and reduce sedimentation.
- Where practicable, sediment must be captured and retained on-site.
- Machinery to be used in carrying out the activities must be selected on the basis of a type and size necessary and capable of safe operation to achieve minimal disturbance of the site.
- Constructed drainage and discharge structures must not alter the natural bed and bank profile.

The qualitative risk assessment identified that the application of the above proposed management measures reduces the residual risk to a low risk (has not happened yet but could, with minor effects on biological or physical environment). Refer to Appendix I3 for further details.

6.2.1.3 Contaminant Mobilisation

Contaminant mobilisation could arise from the use of fuels and chemicals during construction.

Potential Impacts

Potential waste water streams will include oily waste water (from equipment wash water), contaminated runoff from chemical storage areas, and potentially contaminated drainage from fuel oil storage areas, oil-filled transformer yard areas and general wash down water.

The qualitative risk assessment identified this potential impact as a high inherent risk (could happen and has occurred here or elsewhere, with moderate short term effects but not affecting ecosystem). Refer to Appendix I3 for further details.

Mitigation Measures

Bunded storage areas for contaminants will be required, with spill cleanup kits in accordance with Australian Standards (AS1940 and AS3780) to prevent the contamination of surrounding surface runoff. All transfers of fuels and chemicals will need to be controlled and managed to prevent spillage outside bunded areas. Any pollution mobilised in surface runoff, within the construction phase drainage network needs to be contained. Any significant leakage/spillage will be immediately reported and appropriate emergency clean-up operations implemented to prevent possible mobilisation of contaminants. Any rainfall collected in the bunded areas will be allowed to evaporate or be drained and removed to temporary construction sediment ponds. Any

contaminants or major spillages of stored material in the bunded areas will be collected by licensed waste collection and transport contractors for disposal off site at a licensed facility.

Waste water from wash down areas will be directed through oil and grease separators and the water directed to temporary construction ponds for re-use. Separated hydrocarbon material will be collected and periodically removed offsite by licensed waste collection and transport contractors to a licensed recycling/disposal facility.

Without proper mitigation measures, runoff from potentially contaminated drainage from fuel oil storage areas and general wash down water could enter into receiving waters, altering the physical and chemical quality of the water and waterway.

These potential impacts will be mitigated by ensuring:

- Spill cleanup kits, in accordance with Australian Standards (AS1940 and AS3780), will be located in convenient locations such as the work vehicles.
- Refuelling will occur within bunded areas in accordance with AS1940.
- Should a spill occur, it will be contained to ensure that it does not enter drainage lines or watercourses.
- All other operational procedures will be followed.

The qualitative risk assessment identified that the application of the above proposed management measures reduces the residual risk to a moderate risk (has not happened yet but could, with moderate short term effects but not affecting eco-system). Refer to Appendix I3 for further details.

6.2.1.4 Pollution

Potential Impacts

Potential sources of onsite pollution during the construction phase predominantly comprise diesel and other petroleum-based fuels and lubricants used by excavation and construction machinery. Pollution effects are not only on the environment but are also a public health and safety issue.

The qualitative risk assessment identified this potential impact as a high inherent risk (could happen and has occurred here or elsewhere, with moderate short term effects but not affecting eco-system). Refer to Appendix I3 for further details.

Mitigation Measures

Mitigation measures for pollution will be similar to contaminant mobilisation. Bunded storage areas for fuels and dangerous goods for construction equipment will be required, with spill cleanup kits in accordance with Australian Standards (AS1940 and AS3780). All transfers of fuels and chemicals will need to be controlled and managed to prevent spillage outside bunded areas. Any pollution mobilised in surface runoff, within the construction phase drainage network needs to be contained.

Litter and other construction waste could be washed into watercourses during rain events and impact receiving waters. Management of waste is discussed in further detail in Section 14.

The mine site sewage treatment plant will be scheduled to be built as soon as possible to treat sewage from the Contractors amenities. To manage this, a waste management plan will be developed, implemented and maintained, this is also detailed in Section 14.

The qualitative risk assessment identified that the application of the above proposed management measures reduces the residual risk to a moderate risk (has not happened yet but could, with moderate short term effects but not affecting ecosystem). Refer to Appendix I3 for further details.

6.2.1.5 Flooding

Potential Impact

The possibility of out-of-bank (Cherwell Creek, Harrow Creek, Caval Creek – refer Section 6.1.2.3) or flash flood rainfall events during construction, present a risk to workers' health and safety, and can cause erosion and damage to erosion and sediment control infrastructure.

The qualitative risk assessment identified this potential impact as a high inherent risk (could happen and has occurred here or elsewhere, with moderate short term effects but not affecting ecosystem). Refer to Appendix I3 for further details.

Mitigation Measures

It is preferable to avoid major construction during the wet season (November to February), especially within the floodplain. Additionally, stormwater management measures (requirement of the earthworks contractor) such as drainage diversions and bunding will be implemented before works occur. Emergency response procedures and flood forecasting will be incorporated into operating procedures.

The qualitative risk assessment identified that the application of the above proposed management measures reduces the residual risk to a moderate risk (conceivable, but only in extreme circumstances, with moderate short term effects but not affecting ecosystem). Refer to Appendix I3 for further details.

6.2.1.6 Water Supply

Potential Impact

A lack of water supply during the construction phase could mean inadequate dust suppression, soil compaction and wash down facilities allowing sediment movement into neighbouring creeks, leading to deterioration in water quality. The majority of water supply during construction will come from existing water storages in the Peak Downs mining area, including 10N, 11N and 12N dams, and farm dams while a new branch is constructed from the existing Eungella- Bingegang pipeline for the project.

The qualitative risk assessment identified this potential impact as a high inherent risk (could easily happen, with moderate short term effects but not affecting ecosystem). Refer to Appendix I3 for further details.

Mitigation Measures

Sediment and erosion control measures will be developed and a water supply strategy will be developed, implemented and maintained.

The qualitative risk assessment identified that the application of the above proposed management measures reduces the residual risk to a moderate risk (conceivable, but only in extreme circumstances, with moderate short term effects but not affecting ecosystem). Refer to Appendix I3 for further details.

6.2.2 Commissioning Phase

6.2.2.1 Hydrostatic Testing

The integrity of the branch into the Eungella- Bingegang pipeline will be verified by undertaking a hydrostatic test. The pipeline will be tested for strength and leak tightness using water as a test medium. The pipeline will be divided into a number of sections for the testing to be conducted; the limits of each section will be determined by; water source constraints, elevation changes and weather.

The water supply for the testing of the pipeline will be supplied from the Eungella- Bingegang pipeline.

Potential Impacts

The disposal of the water after testing could cause localised erosion and scour or minor flooding.

The qualitative risk assessment identified this potential impact as a moderate inherent risk (could happen and has occurred here or elsewhere, with minor effects on biological or physical environment). Refer to Appendix I3 for further details.

Mitigation Measures

The hydrostatic test water will be discharged to either an existing storage or newly constructed storage and reused during the remaining construction activities.

The qualitative risk assessment identified that the application of the above proposed management measures reduces the residual risk to a low risk (conceivable, but only in extreme circumstances, with minor effects on biological or physical environment). Refer to Appendix I3 for further details.

6.2.3 Operational Phase

During mining operations activities will include:

- Mine prestrip activities including vegetation removal, topsoil strip and stockpile, and drill and blast).
- Open-cut coal strip mining and overburden removal using dragline and truck-shovel operations.
- Progressive rehabilitation of the overburden spoil stockpiles.
- Coal handling, preparation (screening and washing) and transportation.
- Disposal of coarse and fine rejects with the spoil.

The proposed open cut operations have been designed to ensure effective resource extraction within the mining footprint of the mining lease. These processes, however, have potential impacts for the region, surrounding infrastructure and environment during the operational phase. Mitigation measures will be implemented to reduce the expected risk of the impacts and minimise the damage in the case of failure.

6.2.3.1 Water Management System Failures

Potential water management system failures include:

- Storage containment failure caused by inadequate storage capacity, overfilling of the storage, inadequate diversion of clean catchment and/or, extreme weather patterns (ie storm event), which could potentially lead to discharge of poor quality water to the environment (non-compliant discharge).
- Storage embankment failure caused by piping failure (related to poor construction and/or embankment maintenance) or overtopping, which could potentially lead to discharge of poor quality water to the environment (non-compliant discharge).
- Water management system infrastructure failure including:
  - Pipeline failure (potentially caused by machinery damage, weathering, incorrect placement or during relocation).
  - Drain, bunds and/or levee failure (potentially caused by machinery damage, rainfall events, inadequate erosion protection).

This could potentially lead to discharge of poor quality water to the environment (non-compliant discharge).

Potential Impacts

Failure of the water management system could potentially lead to a non-compliant discharge (discharge of poor quality mine water to the environment) which has potential environmental impacts for downstream receiving waters, ecosystems and landholders, including:

- Physical impact of increasing/changing existing flow regimes in receiving waters.
- Poor water quality of mine water compared to the water quality of the receiving environment.
- Alteration of riparian vegetation and aquatic species through increased/altered environmental flows.
- Differences in water quality.
- Erosion and sedimentation could potentially occur at discharge points.

The qualitative risk assessment identified this potential impact as a moderate inherent risk (could happen and has occurred here or elsewhere, with minor effects on biological or physical environment). Refer to Appendix I3 for further details.

Mitigation Measures

The failure of water management systems has specific mitigation measures for the specific potential impacts. Mitigation includes monitoring equipment, consistent inspections of embankment integrity and design and construction supervision, as described in Table 6.5.

Table 6.5 Water Management System Failure Mitigation Measures

Potential Impact	Mitigation Measures
Storage containment failure	Design of water storages has been undertaken using a water balance model which considers all storage inputs and outputs (i.e. rainfall, evaporation, pump transfers etc) and has been run through a long term period of historic climatic data to test the storage capacity against potential sequences of rainfall events, entire wet seasons and potentially sequences of high rainfall wet seasons across several years. The water storages have been designed in accordance with DME 1995 Technical Guidelines. Monitoring equipment will be installed to monitor storage volume during operation combined with a water management strategy to prevent overfilling.
Storage embankment failure	Design and construction supervision of dam embankments will be undertaken by Registered Professional Engineer of Queensland. Regular dam inspections will be undertaken by Registered Professional Engineer of Queensland.
Water management system infrastructure failure	Regular pipeline, drain, bund and levee inspections and maintenance will be undertaken during operation.

Refer to Water Demands and Supply (Section 3) and Mine Water Management (Section 6.2.4) for further details.

Potential impacts will be mitigated using appropriate water management strategy and consistent inspections of water storages and tailings dams supply level and integrity of embankment and spillways.

The qualitative risk assessment identified that the application of the above proposed management measures will reduce the residual risk to a low risk (conceivable, but only in extreme circumstances, with minor effects on biological or physical environment). Refer to Appendix I3 for further details.

6.2.3.2 Erosion and Sediment Mobilisation

The most common activities during operation that can lead to erosion and sediment mobilisation include:

- Open cut mining operations including topsoil stripping, blasting, overburden removal, handling, stockpiling.
- CHPP operations including crushing and stockpiling.
- Earthworks including construction of additional haul road, relocation of back access roads, new drainage and levees.
- Inadequate erosion protection in drains.

Potential Impacts

Erosion and sediment mobilisation can lead to deleterious effects on downstream water quality and aquatic habitats.

The qualitative risk assessment identified this potential impact as a moderate inherent risk (could happen and has occurred here or elsewhere, with minor effects on biological or physical environment). Refer to Appendix I3 for further details.

Mitigation Measures

Potential impacts will be mitigated using appropriate design for erosion and scour protection and a comprehensive mine water management plan.

Additionally, to provide stormwater filtration prior to discharge to receiving waters, swales and buffer strips are recommended. Swales are open vegetated (generally grass) drains, whilst buffers or filter strips are grassed surfaces aligned perpendicular to the direction of flow, which are used to filter particulate matter and associated pollutants from stormwater prior to its entry into the adjacent receiving water. Both swales and buffers provide water quality treatment through physical filtration of water through the vegetation and depending on the retention time some additional pollutant take-up provided by the vegetation.

Progressive rehabilitation of overburden spoil piles will be undertaken to reduce erosion and sedimentation potential.

The qualitative risk assessment identified that the application of the above proposed management measures reduces the residual risk to a low risk (has not happened yet but could, with minor effects on biological or physical environment). Refer to Appendix I3 for further details.

6.2.3.3 Creek Diversions

Sections of Caval Creek and Horse Creek are proposed to be diverted according to ACARP 2000, to allow mining activities and associated mine infrastructure for the project and to maintain existing fluvial processes. Refer to Section 3.7.2.3 for further details on the proposed creek diversions.

Potential Impacts

Diversion of watercourses could potentially lead to the following surface water impacts:

- Erosion and sedimentation
- Flooding impacts.

Erosion and Sedimentation

Construction of creek diversions is expected to change channel flow velocities and stream power (which is a measurement of sediment transport capacity) as compared to the existing creek geometry and alignment. The following list outlines the potential erosion and sedimentation impacts:

- Erosion of the new channel or upstream reaches sufficient to alter creek channel form (shape and plan alignment) in the alluvial sections.
- Sedimentation downstream of the project, either from quantities of sediment mobilised from the new channel or by changed creek hydraulics as a result of the new channel.

Flooding Impacts

The combined effects of the Horse Creek and Caval Creek diversions have the potential to decrease or increase flood levels or change the frequency and extent of flooding in Horse Creek, Grosvenor Creek and Cherwell Creek and in the vicinity of the mine and open cut pits.

The qualitative risk assessment identified this potential impact as a high inherent risk (could happen and has occurred here or elsewhere, with moderate short term effects but not affecting ecosystem). Refer to Appendix I3 for further details.

Mitigation Measures

Erosion and Sedimentation

The creek diversions will be designed in accordance with the Watercourse Diversions – Central Queensland Mining Industry (January 2008), as detailed in Table 6.6.

Table 6.6 Upper Limit Creek Design Threshold Criteria

Channel Type	Stream Power (W/m^2)	Velocity (m/s)	Shear (N/m^2)
2 year ARI event (no vegetation)	<35	<1.0	<40
2 year ARI event (vegetated)	<60	<1.5	<40
50 year ARI event	<220	<2.5	<80

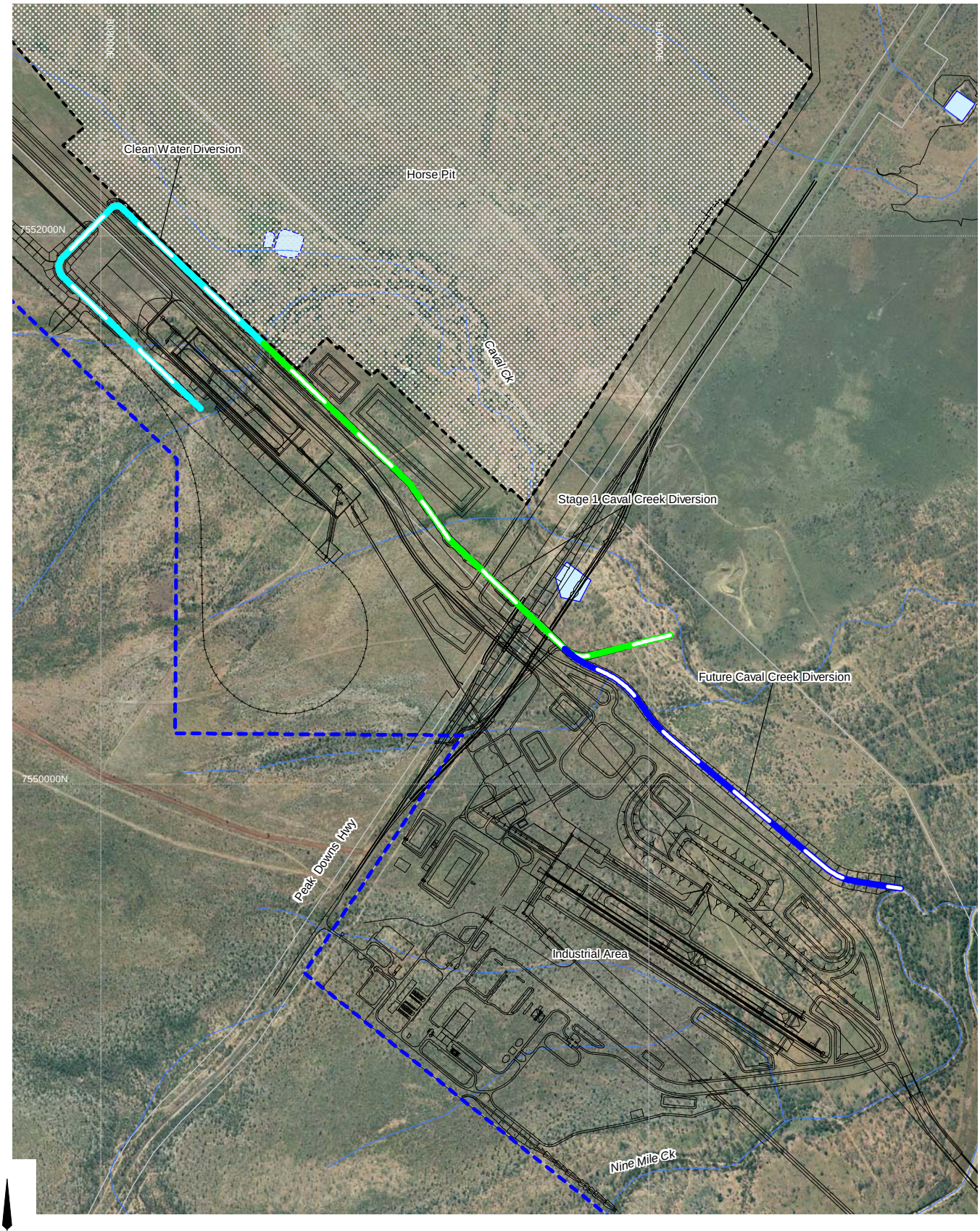
Refer to Appendix I3 and Appendix I2 - Stream Diversion Concept Report for further details.

Flooding Impacts

The modelling used to evaluate hydraulics of the proposed diversions provides an assessment of the impacts on flood levels. The modelling results demonstrate that the:

- Horse Creek design channel has sufficient capacity to convey up to the 100 year ARI flood event. The haul road that is adjacent to the main channel of Horse Creek acts as a bund to protect flooding of the open cut pit.
- Stage 1 Caval Creek diversion has sufficient capacity to convey the flood flows associated with the 100 year ARI event.
- Future Caval Creek diversion has the capacity to contain flows associated with the 100 year ARI events within the designated channel banks.
- Haul road crossing locations of Cherwell and Nine Mile Creek have some significant backwater effects and as a result increase flood depths and extents around the culverts. The Nine Mile Creek culvert crossing has the capacity to adequately pass flows associated with the 20 year ARI and below. However, larger flood events inundate the haul road crossing and increase the flood flow width. The Cherwell Creek crossing, however, has only the capacity to convey a 5 year ARI flood event. Flows greater than the 5 year ARI inundate the haul road crossing and as per Nine Mile Creek increases the flood flow width.

Refer to Appendix I3 and Appendix I2 - Stream Diversion Concept Report for further details.

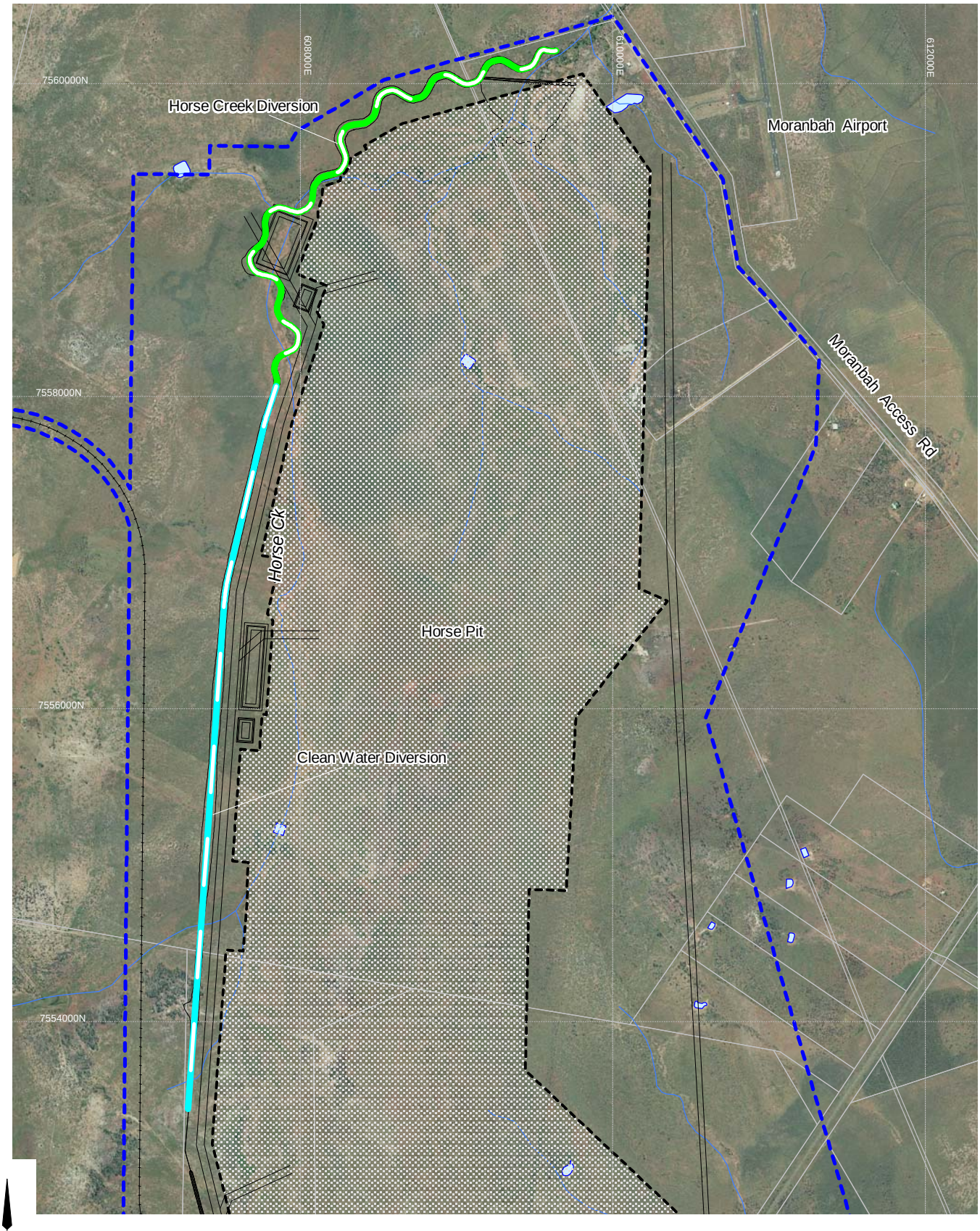


0 250m 500m
Scale 1:20,000 (A4)
Datum: AGD84, ANG Zone 55

Project Site
Proposed Pit
Proposed Infrastructure Components
Clean Water Diversion
Stage 1 Caval Creek Diversion
Future Caval Creek Diversion

Source: Client Supplied Data

Client	Project	Title
BMA BHP Billiton Mitsubishi Alliance	CAVAL RIDGE PROJECT ENVIRONMENTAL IMPACT STATEMENT	**CAVAL CREEK DIVERSION CENTRELINE**
URS	Drawn: VH / Approved: RS / Date: 08-05-2009 Job No: **4262 6158** / File No: 42626158-g-586.wor	Figure: **6.6** / Rev:A / **A4**



0 0.5 1km

Scale 1:35,000 (A4)

Datum: AGD84, AMG Zone 55

Project Site

Proposed Pit

Proposed Infrastructure Components

Clean Water Diversion

Horse Creek Diversion

Source: Client Supplied Data

Client	Project	Title
BMA BHP Billiton Mitsubishi Alliance	CAVAL RIDGE PROJECT ENVIRONMENTAL IMPACT STATEMENT	**HORSE CREEK DIVERSION CENTRELINE**
URS	Drawn: VH / Approved: RS / Date: 08-05-2009	Figure: **6.7**
	Job No: **4262 6158** / File No: 42626158-g-587b.wor	Rev:B / **A4**

Residual Risk

The qualitative risk assessment identified that the application of the above proposed management measures reduces the residual risk to a moderate risk (has not happened yet but could, with moderate short term effects but not affecting ecosystem). Refer to Appendix I3 for further details.

6.2.3.4 Flooding

The construction of mining infrastructure, mining pits and creek diversions has the potential to cause:

- Flooding of project mining areas.
- Flooding of project infrastructure area.
- An increase in regional flooding extents, levels and frequency.

Flooding Impacts

Out-of-bank/flash flood events during the operational phase of the project could result in inundation of the open cut mining pits due to inadequate containment capacity of the designed floodplain. With the existing creek network and proposed diversion channels, some pit inundation is expected to occur for 100 year ARI flood events and higher. Two primary locations have been identified at the northern section of Horse Creek and downstream of confluence of Nine Mile, Cherwell and depending on the Stage 1 or Future Stage diversion option considered, Caval Creek.

In consideration of the project infrastructure, inundation of the haul road crossings are expected to occur for 10 year ARI flood events and greater, with peak velocities for the 100 year ARI event of 3.0 – 3.5 m/s. The haul roads would therefore be impassable for a relatively short period of time.

Mitigation and Management Measures

Stormwater management measures such as drainage diversions and levees should be regularly inspected and maintained during the operation phase. It is recommended that inspections be carried out on a semi-annual basis and after significant storm events to check for erosion, cracking, visible seepage and any other unsuitable conditions. Timely action should be taken to prevent or minimise any actual or potential environmental harm through preventative works. This would aid in the reducing the contributing catchment area to the open cut pits and essential create a turkey nest catchment.

Emergency response procedures (including evacuation procedures) and a flood warning system should be established and incorporated into the site's Health and Safety Environment Plan to protect on-site personnel. Vulnerable infrastructure should be designed with floor levels above a given ARI flood level (this is recommended to be set at the 100 year ARI level) or specific secondary defences should be provided (bunding).

6.2.4 Mine Water Management

The proposed mine water management system is a combination of storages (for water collection and containment) interconnected by open channels, and pumps and pipelines used to transfer mine water between storages, to demands and to dewater mining pits. During the operation of the mine, the areas of disturbance will vary as mining progresses. Therefore the mine water management system will be altered to accommodate these changes.

Mining operations often result in high levels of TDS and salinity within water storages. The potential impacts of non compliant water discharge to the receiving environment may adversely impact upon aquatic ecosystems, subsequently affecting the environmental values within the area.

The mine water management system will be designed and operated to contain dirty water and prevent discharge to receiving water environments and provide water supply for reuse within the CHPP, for industrial use and for haul road dust suppression (refer Section 3). If there is insufficient water available to meet these demands, or the water available does not meet the water quality requirements of the demand, additional water supply will be obtained from the Eungella-Bingegang pipeline.

6.2.4.1 Objectives

In order to protect the environmental values of the downstream receiving waters, the mine water management system has been designed to:

- Divert clean catchment away from areas disturbed by mining activities.
- Progressively rehabilitate spoil stockpiles.
- Contain runoff from all disturbed areas (e.g. haul roads, MIA).
- Maximise reuse of water from the mine water management system to meet mine demands, to reduce likelihood of off-site discharge and requirement for external water supply.

6.2.4.2 Mine Water Storages

Key design criteria of the mine water storages are summarised in Table 6.7, and a summary of the mine water storages is provided in Table 6.8.

Table 6.7 Mine Water Storages - Design Criteria

Type	Design Function	Design Value	Reference
Sediment Basins	Capture runoff from spoil stockpiles (catchment area increases as mining progresses however progressively rehabilitated as mining progresses), mine industrial area and haul roads. Pumps to Mine Water Dam 12N.	Storage Volume designed for – 1 in 10 year ARI. Spillway Capacity – 1 in 100 year ARI. Pump capacity to Mine Water Dam 12N to enable volume to be drawn down in 10 days (third priority after Industrial Area dams are drawn down).	DME Guidelines 1995
Pit/process Water Dams	Containment storage for pit dewatering (likely high salinity and low pH). Supplies CHPP make-up, Industrial Area water usage and dust suppression demands. Pumps to Mine Water Dam 12N.	Storage Volume sized for 1 in 100 year 72 hour 100% run-off for zero uncontrolled discharge. Controlled discharge to receiving waters when proposed EA discharge criteria are met. Sized to be drawn down to 50% capacity in 72 hours where dams have external catchments Spillway Capacity > 1 in 1,000 year ARI for dams with external catchments.	DME Guidelines 1995

Table 6.8 Summary of Mine Water Storages

Storage Name	Function	Overflow Destination
Sediment Basins		
Catchment Dam North	Sediment control and containment storage of the northern Horse Pit run-off from the stripped and unstripped mine lease areas ahead of the high wall (The catchment area reduces as mining progresses). Pumps to Sediment Dam N3 or Mine water Dam N3 when additional water supply is required in the Mine Water Dam 12N.	Horse Creek
Catchment Dam South	Sediment control and containment storage of the Southern Horse Pit runoff from the stripped and unstripped mine lease areas ahead of the high wall (The catchment area reduces as mining progresses). Pumps to Mine Water Dam 12N.	Cherwell Creek
Sediment Dam N1	Sedimentation storage to capture runoff from Horse Pit Spoil stockpiles and haul roads (The spoil pile catchment area increases as mining progresses, however progressively rehabilitated as mining progresses). Pumps to Mine Water Dam 12N.	Caval Creek Cherwell Creek
Sediment Dam N2 and N3	Sedimentation storage to capture runoff from Horse Pit Spoil stockpiles and haul roads (The spoil pile catchment area increases as mining progresses, however progressively rehabilitated as mining progresses). Pumps to Mine Water Dam 12N.	Horse Creek
Sediment Dam S1	Sedimentation storage to capture runoff from Heyford Pit Spoil stockpiles and haul roads (The spoil pile catchment area increases as mining progresses, however progressively rehabilitated as mining progresses). Pumps to Mine Water Dam 12N.	Cherwell Creek

Storage Name	Function	Overflow Destination
Sediment Dam S2 and S3	Sedimentation storage to capture runoff from Heyford Pit Spoil stockpiles and haul roads (The spoil pile catchment area increases as mining progresses, however progressively rehabilitated as mining progresses). Pumps to Mine Water Dam 12N.	Harrow Creek
MIA Sediment Dam 1,2,3 and 4	Sediment basins for sediment capture of runoff from the administration and workshop hardstand areas.	Cherwell Creek
Pit/process Water Dams		
Mine Water Dams N1, N2 and N3	No external runoff. These Mine Water Dams are Horse Pit water Transfer Dams. Containment storage for pit dewatering (likely high salinity and low pH). Pumps to Mine Water Dam 12N.	Mine Water Dam 12N
Process Water Dam	No external runoff. Receives water supply from Southern Mine water Dam 12 North and make-up water from the Raw Water Dam. Supplies CHPP make-up, Industrial Area water usage and dust suppression demands.	Cherwell Creek
Mine Water Dam 12N	Existing Peak Downs Mine water storage Dam 12N. Receives excess pit water from Pits N1, N2, N3 via Mine Water Dams N1, N2 and N3. Receives excess pit water directly from Pit S1, and via transfer from Mine Water Dams S1 from Pits S2 and S3. Receives Stockpile and Remediated land run-off from Sediment Basins N1, N2 ,N3, S1,S2 and S3. Receives ROM, Coal Handling Plant area and Rejects area, Raw Coal Stockpile and Product Coal Stockpile area run-off via Mine Water Dams 1,2,3,4 and 5. Pumps to Process Water Dam. Supplies haul road dust suppression demand.	Controllled releases to Cherwell Creek
Mine Water Dam S1	No external runoff. This Mine Water Dam is the as a pit water transfer dam for Pits S2 and S3. Containment storage for pit dewatering (likely high salinity and low pH) Pumps to Mine Water Dam 12N.	Mine Water Dam 12N
Mine water Dams 1, 2, 3, 4 and 5	Captures runoff from ROM, Coal Handling Plant area and Rejects areas. Various storages throughout the mine industrial area. Can contain contents of tailings thickener. Pumps to Mine Water Dam 12N.	Pumps to Mine Water Dam 12N

6.2.4.3 Licence Requirements

Some of the mine water storages listed in Table 6.8 may require licensing as follows:

- As Referable Dams under the Water Supply, Safety & Reliability Act 2008; or
- As Hazardous Dams under the Department of Mines and Energy's Site Water Management Technical Guideline for Environmental Management of Exploration and Mining in Queensland 1995.

The licensing requirements will be assessed during the detailed design phase of the project. The assessment requirements are outlined in the following sections.

Referable Dams

Failure impact assessment is required if the storage does not contain hazardous waste, is more than 8 m in height and has:

- A storage capacity of more than 500 ML; or
- A storage capacity of more than 250 ML and a catchment area that is more than 3 times the maximum surface area of the storage.

Preliminary assessments suggest that it is unlikely that any of the storages listed in Table 6.8 will be referable dams.

Hazardous Dams

For each storage, the highest individual hazard category from the following will be adopted for the dam:

- Hazard category for loss due to contamination will be assessed according to the likely effect of the failure of the system or component and its degree of severity in terms of:
  - loss of human life
  - loss of stock
  - environmental damage.
- Hazard category for dambreak situations will be assessed according to the resulting loss of life and property in terms of:
  - loss of human life
  - direct economic loss
  - indirect economic loss.

Preliminary assessments indicate that process water dams and mine water dams may be classified as hazardous dams. The assessment will be finalised during the detailed design phase of the project.

6.2.4.4 Flood Protection Levees

Flood protection will be provided via the haul road running adjacent to the proposed diversion of Horse Creek and the flood protection levees that will be constructed around the perimeter of Hey and Horse Pits, excluding the stockpile areas that act as a form of flood protection bund, to prevent pit inundation.

6.2.4.5 Creek Diversions

The locations of the creek realignments and diversions are shown in Figure 6.6 and Figure 6.7.

Caval Creek Diversion

There are two stages for the Caval Creek diversion:

- Stage 1 Caval Creek diversion is a partial diversion of Caval Creek around the product stockpile and rejoining Caval Creek further downstream (this includes a clean water diversion upstream of Caval Creek). Stage 1 Caval Creek diversion has been designed so that the future stage can be constructed, without changes to the Stage 1 Caval Creek diversion.
- Future Stage Caval Creek diversion (combined with Stage 1 Caval Creek diversion is a complete diversion of Caval Creek, around the proposed pit location and perpendicular to the CHPP, joining Cherwell Creek further downstream than the existing location.

The alignment of the two stages of the Caval Creek diversion is shown in Figure 6.6.

Horse Creek

The Horse Creek diversion (including a clean water diversion upstream of Horse Creek), diverts Horse Creek flows adjacent to the haul road that runs along the length of the proposed open cut pit and along the mining lease boundary. The haul road will act as a bund to protect the open cut pit from flooding during larger events.

The alignment of Horse Creek diversion is shown in Figure 6.7.

Design Objectives

The creek diversions have been designed in accordance with the following design objectives:

- Comply with DERM Watercourse Diversions – Central Queensland Mining Industry - Upper Limit Creek Design Threshold Criteria; and
- Minimal ongoing maintenance and modification, achieved through maintaining a constant diversion bed grade and no flow control structures, such as drop structures.

Refer to Appendix I and Appendix I2 - Stream Diversion Concept Report for further details.

Creek Diversion Licence Requirements

The creek diversions require licences under the *Water Act 2000* to interfere with the flow of water. Licence applications have been submitted to NRW, refer to Appendix I2 – Stream Diversion Concept Report (SKM, 2009) for supporting information.

Creek Diversion Monitoring and Evaluation

As mentioned in ACARP 2001, diversions need to be designed using hydrologic, hydraulic and geotechnical information. An understanding of the influence and interaction between sediment transport, hydrology, soils, land use, and vegetation on operation of diversions is needed.

Monitoring of diversions is required to identify potential accelerated bank erosion, bed degradation or increased sediment deposition, to prevent compromising their function.

Creek Diversion Rehabilitation

The proposed diversion of Caval Creek and Horse Creek will create an altered riverine environment which will require effective, long-term and sustainable revegetation and geomorphic settings, consistent with existing natural reaches of the creeks.

6.2.4.6 CHPP Water Management

The water management within the CHPP area will be as follows:

- Cut off drains upstream of the CHPP pad will allow clean water to bypass the CHPP area;
- Runoff from dirty water falling within the CHPP area will drain to Industrial Area Runoff Dams;
- In case of an emergency discharge from the tailings thickener, the thickener tailings will be pumped to the Process Water Dam(s), which have been sized to contain the contents of the thickener tailings. Recovery of the thickener tailings will be undertaken by pumping/decanting water off the dam(s) and then recovering the settled tailings for removal to the tailings storage facility.

6.2.4.7 Wastewater Treatment

A sewage treatment plant will be constructed to treat wastewater to Class A+ as defined by Queensland Water Recycling Guidelines (December 2005). The water quality design specifications for Class A+ is detailed in Table 6.9.

Table 6.9 Class A+ Effluent Water Quality Design Specifications

Quality Characteristic	Proposed Sewage Treatment Plant		
	Minimum	Maximum	95th Percentile
5 Day BOD (mg/L)		20	60
Faecal Coliform (cfu/100mL)	See below		
E. Coli (cfu/100mL) Clostridium perfringens (cfu/100mL) F-RNA bacteriophage (pfu/100mL) Somatic coliphage (pfu/100mL)		1	10
Suspended Solids (mg/L)		5	15
Electrical Conductivity (µS/cm)		1,600	
pH	6.5		8.5 max
Total Nitrogen (mg/L)		5	15
Total Phosphorus as P			15
Residual Cl_2	0.7		
Oil and Grease (mg/L)			10
NTU		2	5
Ammonia (mg/L)		1	3
DO (mg/L)	2		

Following treatment, the effluent will be discharged to the Process Water Dam and used in mine operations. A separate recycled effluent pipe system will be installed with appropriate signage placed on all taps in accordance with the Queensland Water Recycling Guidelines.

Sludge will be treated in a bioreactor and removed from site and disposed of by a local contractor.

Monitoring will be undertaken in accordance with the Queensland Water Recycling Guidelines, including weekly sampling and testing for the first year of operation and monthly thereafter.

6.2.4.8 Water Balance Model

A water balance model was developed to simulate runoff from mine catchments and receiving water catchments in response to rainfall, and then capture, collection, transfer, reuse and releases of water from the proposed mine water management system.

The water balance model was developed using the modelling software program GoldSim, which can model continuous systems and balance the movement of water with time based inputs and operating rules. A schematic of the water management system, used to develop the water balance model is detailed in Figure 6.8.

The main drivers of the water balance model were to:

- Prevent the discharge of potential contaminated mine water;
- Ensure continuity of supply to the mine processes; and
- Ensure that water is available for dust suppression.

While at the same time minimising:

- The volume of the storages;
- The capacity of the pumps; and
- The lost working time due to pit flooding.

Water Supply Results

The water balance model was able to optimise the storage volumes to supply enough water to operate the site for in excess of 85% of the time.

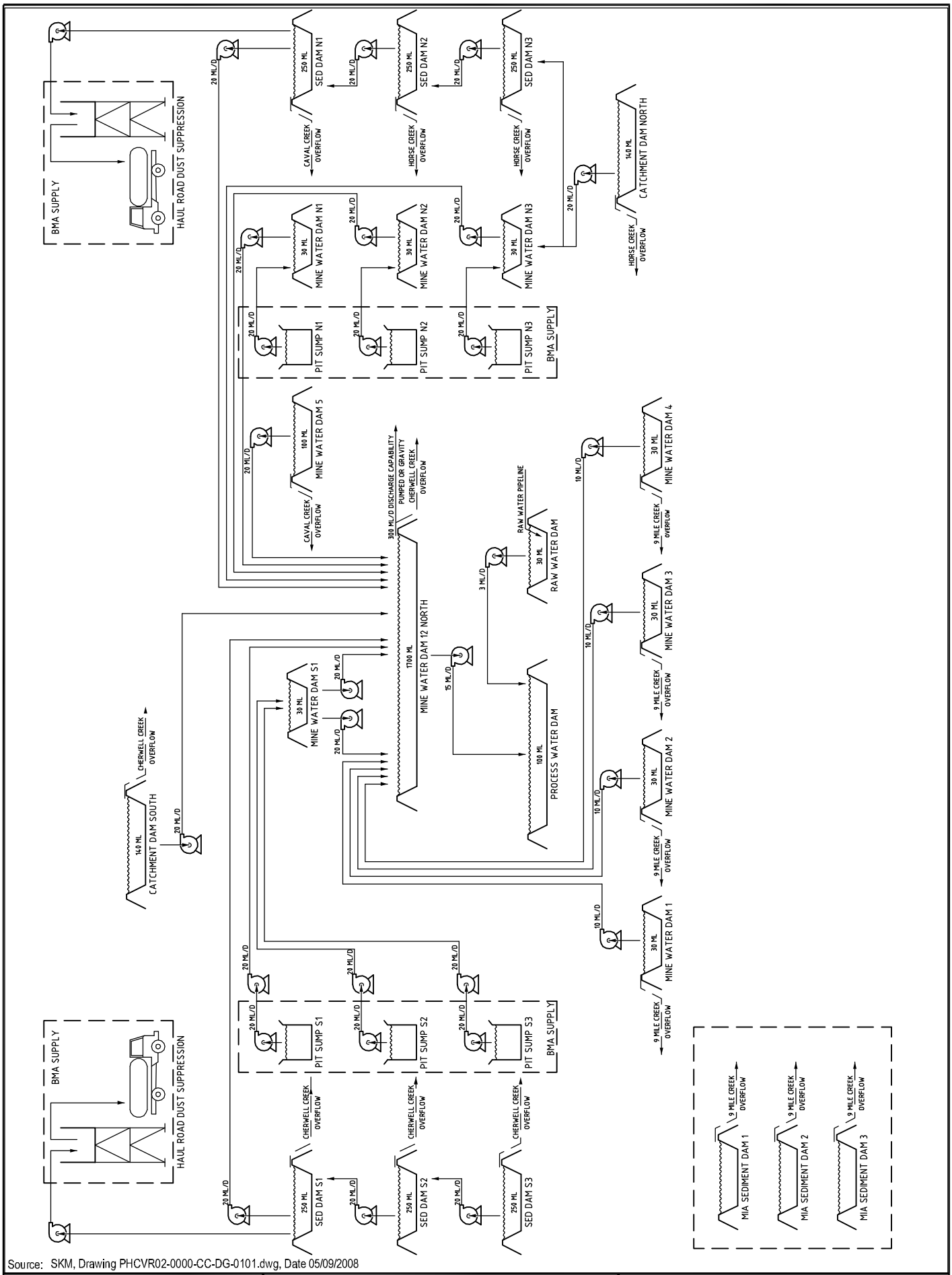
Pit Flooding

The number of days per year when pits are likely to contain greater than 10 ML of mine water ranges from 1 – 4 days per year.

Discharges

The water balance model results indicate that there are no uncontrolled releases from the water management system.

Controlled releases shall occur from Mine Water Dam 12 North when there is flow in Cherwell Creek and a maximum Electrical Conductivity of 1,500 µS/cm can be achieved at the discharge point.



Source: SKM, Drawing PHCVR02-0000-CC-DG-0101.dwg, Date 05/09/2008

Client	Project	Title
BMA BHP Billiton Mitsubishi Alliance URS	CAVAL RIDGE PROJECT ENVIRONMENTAL IMPACT STATEMENT	**WATER BALANCE MODEL SCHEMATIC**
	Drawn: VH / Approved: RS / Date: 08-05-2009	Figure: **6.8** / Rev. A
	Job No.: 42626158 / File No.: 42626158-g-588.dwg	A4

6.2.4.9 Monitoring Program

A surface water monitoring program will be established for the project site, including:

- Permanent water quality and flow monitoring points established upstream and downstream of Horse Creek, Caval Creek, Cherwell Creek (currently monitored by Peak Downs Mine), Nine Mile Creek and Harrow Creek (currently operated by Peak Downs Mine). Regular sampling at the following locations:
  - Mine Water Storages as listed in Table 6.8;
  - Pit sumps.

Parameters monitored will include pH, TDS, TSS, anions, cations and metals, in line with the water quality objectives identified in Section 6.1.3.

6.2.4.10 Mine Water Management System Releases

In Queensland, effluent discharges to the freshwater environment are regulated by the DERM. When new infrastructure is proposed, a licensing agreement is formed as part of the planning process, to permit offsite discharges. This section proposes discharge limits of the mine water entering the receiving environment.

The proposed discharge locations (Figure 6.9) for the project will be on:

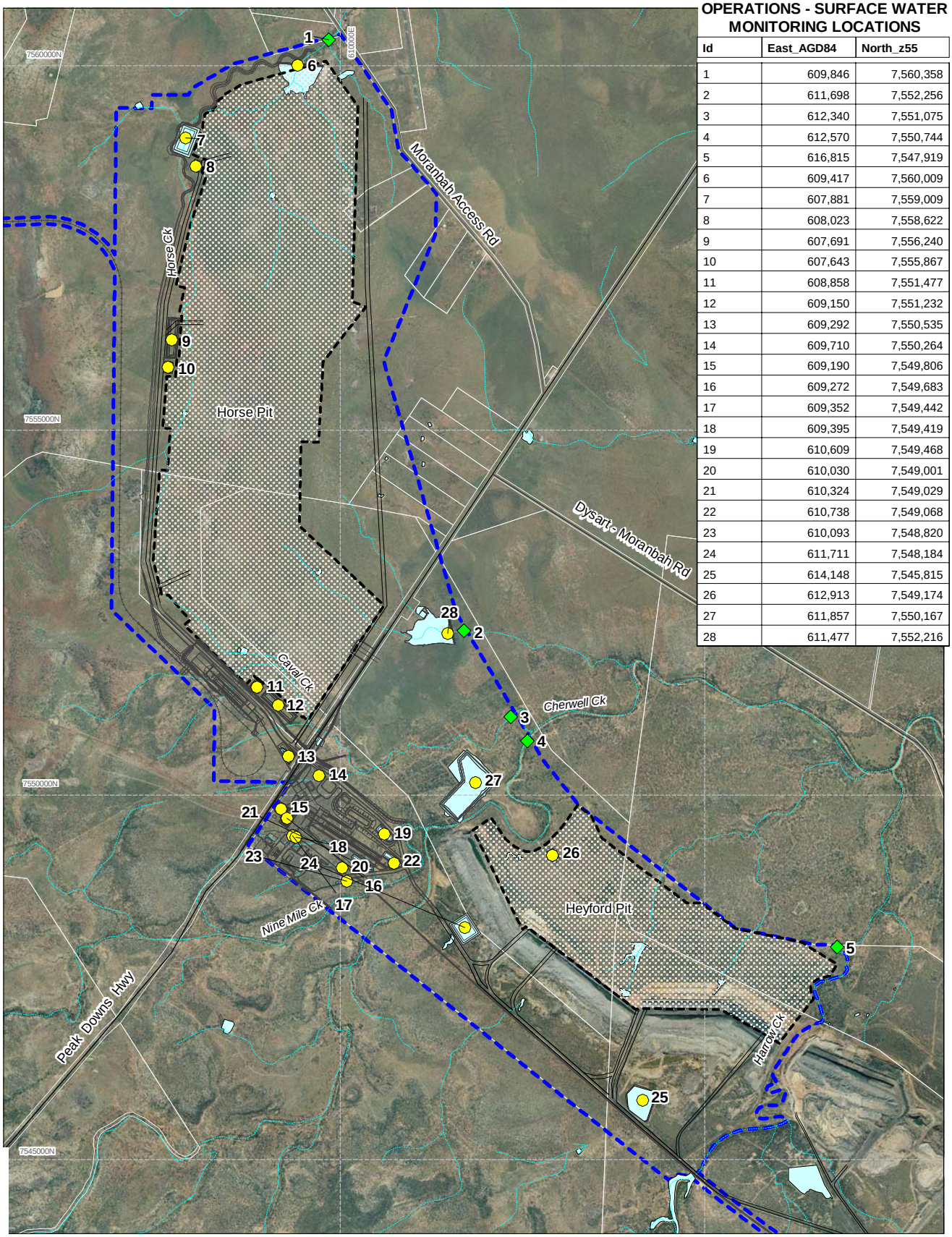
- Cherwell Creek
- Nine Mile Creek
- Horse Creek
- Harrow Creek
- Caval Creek
- Cherwell Creek Tributary.

Receiving Waters Monitoring

Daily during discharge, the upstream and downstream water quality and flow monitoring points will be monitored for receiving water quality within the following limits:

- EC < 2,500 µS/cm
- pH 6 – 9.

It must be noted that the water quality objectives proposed in this report should be used as a guide and that agreement with the DERM is required.



OPERATIONS - SURFACE WATER MONITORING LOCATIONS

Id	East_AGD84	North_z55
1	609,846	7,560,358
2	611,698	7,552,256
3	612,340	7,551,075
4	612,570	7,550,744
5	616,815	7,547,919
6	609,417	7,560,009
7	607,881	7,559,009
8	608,023	7,558,622
9	607,691	7,556,240
10	607,643	7,555,867
11	608,858	7,551,477
12	609,150	7,551,232
13	609,292	7,550,535
14	609,710	7,550,264
15	609,190	7,549,806
16	609,272	7,549,683
17	609,352	7,549,442
18	609,395	7,549,419
19	610,609	7,549,468
20	610,030	7,549,001
21	610,324	7,549,029
22	610,738	7,549,068
23	610,093	7,548,820
24	611,711	7,548,184
25	614,148	7,545,815
26	612,913	7,549,174
27	611,857	7,550,167
28	611,477	7,552,216

0 1.25 2.5km

Scale 1:75 000 (A4)

Datum: AGD84, AMG Zone 55

Project Site

Proposed Pit

Surface Water Monitoring Location

Receiving Water Monitoring Location

Source: BMA Supplied Data (November 2007)

Client

BHP Billiton Mitsubishi Alliance

URS

Project

CAVAL RIDGE PROJECT
ENVIRONMENTAL IMPACT STATEMENT

Title

OPERATIONS SURFACE WATER MONITORING LOCATIONS

Drawn: VH	Approved: RS	Date: 08-05-2009
Job No: **4262 6158**	File No: 42626158-g-594.wor	

Figure: **6.9**

Rev:A

A4

6.2.5 Decommissioning Phase

Should project-related infrastructure require decommissioning, negotiations with relevant stakeholders will be undertaken as to the benefits of retaining some of the infrastructure for future use (e.g. roads, hardstand, dams etc). Infrastructure will only be left after decommissioning where formal written agreements have been obtained from the relevant stakeholders for its use and maintenance/management. A description of the decommissioning process is provided in Section 4.8.9.2.

In relation to surface water infrastructure if sediment ponds are not to remain, these will be drained, filled, topsoiled and revegetated and the original drainage paths re-established wherever possible. The sediment ponds are anticipated to be present at the time of decommissioning to assist with the provision of water for rehabilitation, where necessary.